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Curvin Henry Gingrich
1880-1951

By FREDERICK C. LEONARD

On Sunday morning, June 17, 1951, after an illness that had lasted only one week, Dr. Curvin Henry Gingrich, for many years Professor of Mathematics and Astronomy in Carleton College and Editor of POPULAR ASTRONOMY, died in Northfield, Minnesota, from a heart attack. The news of his death came as a severe shock to his many friends and associates, most of whom had not known that he had been even indisposed. The last time I saw him, just about a year ago in San Diego, he was the very personification of life, health, and vigor, looking and acting more like a man in his early fifties than one in his late sixties. It was difficult to realize that he would be 70 years old his next birthday, for he seemed to have many years of useful activity ahead of him.

I first met Curvin H. Gingrich, familiarly and affectionately called "Ging" by all his close friends in the astronomical world, when he was a graduate student at the Yerkes Observatory and the University of Chicago, where he studied, part time, from 1909 to 1912, and from which he took his Ph.D. degree in astronomy in the latter year. I vividly remember the genial and modest young man with the quiet little laugh, then a candidate for the doctorate, who was liked by everybody in the Observatory community at Williams Bay. Although he and I exchanged innumerable letters in the 18 years from 1933, when the Meteoritical Society was founded and commenced publication of its *Contributions* in POPULAR ASTRONOMY, until nearly the day of his death, I saw Dr. Gingrich on only three occasions, all in the years 1949 and 1950: first, on a day in the late spring or early summer of 1949, when he and his gracious wife were visiting in the Los Angeles area; next, at the 82nd Meeting of the American Astronomical Society held at the University of Arizona in Tucson, from December 28 to 31 of that same year; and last, on July 10, 1950, when he was teaching as visiting professor of mathematics and astronomy in the summer session of the San Diego State College, and he and Mrs. Gingrich were again sojourning in Southern California. Yet I felt that I knew him well, if not intimately, for even his correspondence reflected his uncommon personality—that of the true gentleman and scholar; his sympathetic interest, active coöperation, and never-failing help made him one of the rarest individuals with whom it has been my privilege ever to be associated. Possibly no one in this world is indispensable, but

Curvin H. Gingrich came about as close to being that as anybody whom I have personally known.

In an account of this kind it is customary to record the main events of the life and career of the subject. These may now be briefly set down.

Curvin Henry Gingrich was born on November 20, 1880, in York, Pennsylvania, the son of William Henry and Ellen Kindig Gingrich. He graduated with an A.B. degree from Dickinson College, Carlisle, Pennsylvania, in 1903, from which he took also an A.M. degree in 1905, and which, as his alma mater, conferred upon him the honorary degree of Doctor of Science in 1941. As previously stated, he did graduate work from 1909 to 1912 at the University of Chicago and its Yerkes Observatory, from which he received the Ph.D. degree in 1912. As a young man he taught mathematics at Maryville Seminary, Maryville, Missouri, from 1903 to 1905; at Northwest Missouri College, Albany, Missouri, from 1905 to 1907; and at Baker University, Baldwin, Kansas, from 1907 to 1909. In 1909, as an instructor, he joined the faculty of Carleton College, in Northfield, Minnesota, with which he was continuously connected for 42 years until the date of his death, when he was the senior member of that faculty and had reached the age of retirement. He was promoted to professor of mathematics and astronomy at Carleton College in 1912, and he also served for many years as Chairman of its Department of Mathematics. He was Acting Dean from 1914 to 1915, Dean from 1915 to 1917, and Assistant to the President, and Registrar, from 1917 to 1919.

Dr. Gingrich taught as a visiting professor in the summer of 1920 at the University of Minnesota; in the summer of 1922 at the University of Chicago; in the summers of 1929 and 1930 at Columbia University; and in the summer of 1950, the last summer of his life, at the San Diego State College. He attended sessions of the International Astronomical Union held in Bonn, Germany, in 1913, and in Leyden, Holland, in 1928. In the latter year he also attended a Congress of Mathematicians in Bologna, Italy. He lectured at the Adler Planetarium and Astronomical Museum in Chicago in the summers of 1931, 1932, and 1933 (during the Century of Progress Exposition), and he did research at the Mount Wilson Observatory in 1921-22, and at the Leander McCormick Observatory of the University of Virginia in the summer of 1935. His investigational work at the Goodsell Observatory at Carleton College, of which he was a regular staff member, and at other observatories with which he enjoyed temporary connections, was in the several fields of the micrometric measurement of cometary positions and of double stars, celestial photography, the photographic determination of the positions of minor planets, and of stellar parallaxes and proper motions, and stellar photometry. He was the author of numerous scientific papers and reports in these various fields, many of his articles having been published in POPULAR ASTRONOMY. He was a

member of the American Astronomical Society, the Mathematical Association of America, the honor societies of Phi Beta Kappa and Sigma Xi, and the fraternity of Kappa Sigma. He was a charter member of the Phi Beta Kappa and Sigma Xi chapters at Carleton College and served as either president or secretary of the former chapter continuously since its establishment there in 1914. At the time of his death, he was an honorary member of the American Association of Variable Star Observers, and he was a fellow, a patron, and a Councilor of the Meteoritical Society. He played a most important part in the affairs not only of the Variable Star Association and the Meteoritical Society but also of the American Meteor Society, for all three of those societies, ever since their inception, have employed POPULAR ASTRONOMY as their official organ. Last but not least from his point of view certainly, it should be mentioned that he was an active Mason and a strong Methodist.

In 1910, when he was an instructor at Carleton, Mr. Gingrich was appointed Assistant Editor of POPULAR ASTRONOMY, under the late Dr. Herbert C. Wilson, the second Editor of the magazine. From that time on until the day of his death, more than 40 years later, Curvin H. Gingrich was uninterruptedly connected in some editorial capacity with this "review of astronomy and allied sciences." In 1912, the year in which he took his doctorate at Chicago and was made Professor of Mathematics and Astronomy at Carleton, he became Associate Editor of POPULAR ASTRONOMY, and, finally, in 1926 he succeeded Dr. Wilson as the third Editor of this journal. As Editor, Dr. Gingrich was chiefly responsible for all of the 25 volumes of the magazine that have been published in the last quarter of a century. The following editorial entitled, " 'Press Proof OK—CHG,' "— a fitting tribute to Dr. Gingrich from one of his fellow townsmen—appeared in the June 21, 1951, issue of the *Northfield News,* in the plant of which POPULAR ASTRONOMY has been printed for over 50 years:

"The sad news that Curvin H. Gingrich, for 42 years a beloved and highly respected member of the Carleton College faculty, had passed away at our city hospital Sunday morning after only a week's illness was received with sincere sorrow by members of *The News* staff.

"During his long tenure as Professor of Mathematics and Astronomy at Carleton, many generations of students sat in the classroom of this Christian gentleman and scholar, and they remember him with affection as a great teacher.

"At *The News* we learned to know him intimately through our many contacts with him as the Editor of POPULAR ASTRONOMY, which has been printed in *The News* plant for more than half a century.

"Dr. Gingrich had been associated with this scientific magazine since he came to Carleton in the fall of 1909, and had been its Editor since 1926. He succeeded Professor Herbert C. Wilson, and was the third

Editor of the publication since it was established in 1882 by Professor W. W. Payne as *The Sidereal Messenger*.

"During the past quarter century, the Editor of *The News* has made many trips to Dr. Gingrich's office in Goodsell Observatory with press proofs of POPULAR ASTRONOMY marked 'Rush. . . .' receiving always a genial greeting from this patient and painstaking Editor.

"Minutes later, the message would come to the waiting pressman at *The News*: 'Press Proof OK—CHG.' Then the press would start rolling, and another issue of 'P.A.' would be on its way as a friendly messenger from Northfield to directors of observatories and teachers and students of astronomy throughout the world.

"At *The News* it will be difficult to become adjusted to the fact that no more 'P.A.' press proofs will be OK'd by Editor Gingrich.

"Of him it can truly be said that Christianity was a way of life which he exemplified in his daily contacts with students, faculty and church colleagues, friends, and neighbors.

"Through the life he lived he has earned the OK of the Great Judge who scans the press proofs of each of us, and he will be welcomed with a 'Well done, thou good and faithful servant!' "

A friend on the faculty of DePauw University, Greencastle, Indiana, has written: ". . . we also want to express our appreciation of Doctor Gingrich: not only a recognized scientist and scholar, but, as the editorial in the *Northfield News* so aptly stated, 'a Christian gentleman.' A man may, of course, be all these things and still not add up to the inimitable personality, so modest, so quick, so gay—utterly charming. No wonder he had only friends among scientists, colleagues, and hosts of students!"

Having reached the age of 70 on November 20, 1950, Dr. Gingrich was due to retire on June 30, 1951, at the end of the academic year 1950-51. His death came, then, almost on the eve of his retirement, and in commencement week. He had planned to carry a part-time program of work at Carleton College during the current academic year, 1951-52 —to retire from teaching but to continue as Editor of POPULAR ASTRONOMY. It must, I am sure, be a source of sadness to everyone who was associated with him that the realization of that plan and many more years of fruitful service, even in partial retirement, were denied him by death. It is, however, a satisfaction to know that already a "Curvin H. Gingrich Memorial Scholarship Fund" has been established at the college he served so long, so well, and so faithfully, through gifts from former students and from friends.

The funeral service for Dr. Gingrich was conducted in Skinner Memorial Chapel on the Carleton College campus by the Reverend Richard G. Douglas, pastor of the Northfield Methodist Church, and Dr. Laurence M. Gould, president of Carleton College. The following is an excerpt from Dr. Gould's remarks:

"Curvin Gingrich was a good man. I think this is the best thing that

can be said of any man. The best thing Jesus' biographer could say about Jesus was that he went about doing good. When God finished making the universe, as recorded in Genesis, he looked upon it and the best thing he could think to say was, 'It is very good.' I think he meant that it fulfilled its purpose. No higher eulogy than that could be pronounced on anyone or anything.

"I think these lines from the Chinese poet Lao Tzu suggest the universally high opinion in which Curvin Gingrich was held by his colleagues on the Carleton faculty:

> 'He does not make a show of himself,
> Hence he shines;
> Does not justify himself,
> Hence he is glorified;
> Does not boast of his ability,
> Hence he gets his credit;
> Does not brandish his success,
> Hence he endures;
> Does not compete with anyone,
> Hence no one can compete with him.'"

The Reverend Mr. Douglas closed his remarks by saying, "For over forty years this teacher and friend dwelt among us and blest us with his integrity and his vision. Like Moses before him, he wist not that his face shone."

Dr. Gingrich is survived by his wife, the former Mary Ann Gross, whom he married on August 10, 1915; by their daughter, Gertrude, now Mrs. Robert C. Feather of Morgantown, West Virginia; by their two grandsons, Robert Gingrich Feather and Hugh Curvin Feather, also of Morgantown; and by his sister, Mrs. Charles Helzer of York, Pennsylvania.

In concluding this brief and inadequate memorial, I am reminded of the epitaph of Sir Christopher Wren, himself an astronomer, as well as the architect of St. Paul's Cathedral, in which his remains lie buried under an inscription that ends with the words:

> "LECTOR, SI MONUMENTUM REQUIRIS,
> CIRCUMSPICE"

—"Reader, if thou seekest his monument, look around." Does not this same sentiment apply equally well here, even if figuratively, to Curvin Henry Gingrich—for do not the last 25 volumes of POPULAR ASTRONOMY, which he edited, constitute the greatest and most enduring monument to his scholarly and scientific achievements?

DEPARTMENT OF ASTRONOMY, UNIVERSITY OF CALIFORNIA, LOS ANGELES,
1951 JULY 6.

The Eighty-Fifth Meeting of the American Astronomical Society

By C. M. HUFFER

The eighty-fifth meeting of the American Astronomical Society was held in Washington, D. C., June 20-23, 1951. The meeting celebrated in part the 100th anniversary of the founding of the Nautical Almanac Office and the 50th anniversary of the founding of the National Bureau of Standards. The invitation came jointly from the two institutions and arrangements were made by a joint committee under the direction of Dr. C. C. Kiess.

Headquarters were in the Wardman Park Hotel; sessions for papers were in the lecture room of the East Building of the Bureau of Standards; and two evening social functions—an informal reception and the Society dinner—were held at the U. S. Naval Observatory. Various extra functions were scheduled and enjoyed by large numbers of members of the Society and their guests.

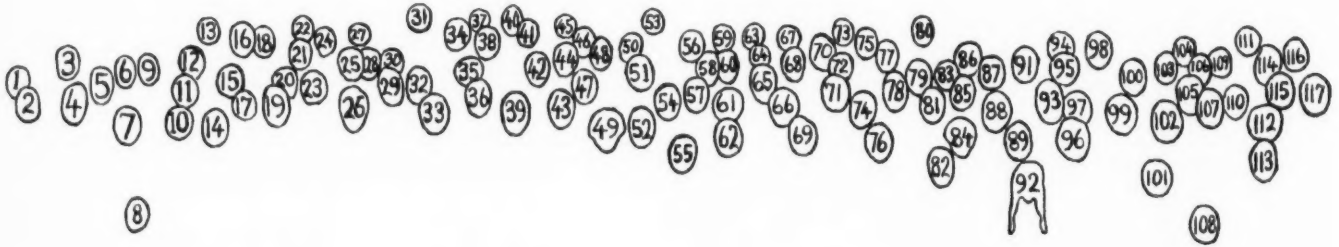
As usual, the business affairs of the Society were conducted by the Council, which met in the official suite of the hotel in the afternoon and evening of the first day while the astronomers were gathering. The registration desk was located in the lobby of the hotel and moved on the following morning to the Bureau of Standards where it remained during the sessions.

The opening session was called to order by President Joy at 9 A.M. on June 21. We were first welcomed by Commander E. C. Long, Acting Superintendent of the Naval Observatory, and Dr. William F. Meggers, who was asked to substitute for the Director of the Bureau, Dr. E. U. Condon. We were informed that Dr. Condon had been called to a meeting which had to do with a budget hearing—presumably governmental figures.

The real business of the meeting started with a paper by Dr. Paul Herget, followed in the four sessions for contributed papers by 57 others. The program listed 58 papers and there were two extra on the supplementary program, but the authors of two papers were unable to appear and their papers were cancelled. At the request of the President, the authors very kindly coöperated in shortening their papers and a few were combined with another paper from the same observatory. But the Council does not trust any author and strict timing was done by the Director of the Naval Observatory. By such devices all papers were finished shortly before noon on the last day.

The symposium on Friday morning should be mentioned especially. It had been announced that Professor Russell would preside at the symposium, but he was unable to be present and his place was capably

KEY TO GROUP PICTURE (*a*)



1. Gleim
2. Paul Jose
3. Robert La Fara
4. Lane
5. Wright
6. Mrs. La Fara
7. Mrs. Lane
8. Lane, Jr.
9. Chamberlain
10. Miss Farnsworth
11. Miss Williams
12. Miss Sawtell
13.
14. Mrs. Maxwell
15. Mrs. Chamberlain
16. Cameron
17. Mrs. Cresson
18. Goldberg
19. Maxwell
20. Haro
21. Weston
22. de Jonge
23. Mrs. Nail
24. Sitterly
25. Dyer
26. Edmonson
27. Miss Swope
28. Miss Lauterbach
29. Nelson
30. Mrs. Sitterly
31. Keller
32. Miss Risley
33.
34.
35. Miss Stahr
36. Miss Jenkins
37. Prendergast
38. Herget
39. Stephens
40. A. Shapley
41. Wrubel
42. Haupt
43. Vyssotsky
44. Goedicke
45. Roberts
46. Ledoux
47. Edelson
48. Whipple
49. Mrs. Stephens
50. Merrill
51. Draper
52. Huang
53. Wood
54. Kum?
55. Mrs. Edelson
56. Miss Johns
57. Woolard
58. Olivier
59. Keenan
60. Eckert
61. Miss Herget
62. Miss Weber
63. Herzberg
64. Miss Hill
65. Linnell (?)
66. Mrs. Herget
67. Chandrasekhar
68. Herr
69. Mrs. Clemence
70.
71. Mrs. Henry Smith (?)
72. Mrs. Furman
73. Spitzer
74. Donn
75. Strömgren
76. Gossner
77. van de Hulst
78. Smith (Henry J.)
79. Boggess
80. Babcock
81. Gossner
82. Miss Federer
83. Mrs. Lewis
84. MacDonald
85. King
86. Hetzler
87. Potter
88. Kameny
89. Kiess
(No number 90.)
91. Williamson
92. Ann Nail
93. Mumford
94. Genatt
95. Hedeman
96. Mrs. Albers
97. Miss Jones
98. MacRae
99. Mrs. Nassau
100. Mikesell
101. Nicky Spitzer
102. Nassau
103. Matthews
104. Hagen
105. Albers
106. Federer
107. Huffer
108. Cosy Spitzer
109. Miss Lippincott
110. Mrs. Federer
111. Dimitroff
112. Mrs. Spitzer
113. Tony Federer
114. McCuskey
115. Zirin
116. Thomas
117. Brouwer

THE EIGHTY-FIFTH MEETING OF THE AMERICAN ASTRONOMICAL ASSOCIATION, WASHINGTON, D. C., JUNE 20-23, 1951.—(*a*)

(KEY AND NAMES ON REVERSE SIDE)

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(KEY AND NAMES ON REVERSE SIDE)

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The Society Dinner was the final social affair of the meeting. During the war the Naval Observatory built a cafeteria to accommodate the increase of employees. This cafeteria is no longer used for that purpose but on June 22 was filled with 200 astronomers who partook of an excellent dinner of fried chicken.

Following the dinner President Joy introduced Admiral Hartman, Deputy Chief of Naval Operations, who spoke for the Navy Department. He was followed by Father Francis Heyden of Georgetown University and Dr. Allen D. Maxwell of Howard University. Dr. Bengt Strömgren, who is the new director of Yerkes Observatory and is the Secretary of the International Astronomical Union, reported on present activities of the I.A.U. and told us for the first time in public why the meeting scheduled for Leningrad this summer had been postponed. It may be that the Air Corps thought Dr. Strömgren was giving away some secrets, since they sent a large plane over the building which obliterated some of his remarks. As a gesture of good will toward our guests from other nations, Dr. Guillermo Haro of Mexico and Dr. P. Ledoux of Belgium were recognized by the President and saluted by the members of the Society.

In recognition of the anniversaries being celebrated Vice-president Brouwer saluted the Nautical Almanac and reviewed briefly the history of the founding and work of the Almanac office. Commander E. C. Long responded. Former President Shapley gave the salute to the Bureau of Standards and outlined ten contributions which the Bureau had made to science in the 50 years of its existence. Dr. Condon replied for the Bureau.

The summer meeting of the Society always includes the annual meeting, which was held at 2 P.M. on Friday, June 22. President Joy presided. He first asked the Secretary to read the names of 24 new members who had been elected to membership by vote of the Council, as follows:

Dr. William A. Baum, Mt. Wilson and Palomar Observatories.
Dr. Victor M. Blanco, Universidad de Puerto Rico.
Mr. Robert J. Davis, Harvard College Observatory.
Mr. Richard B. Dunn, Harvard College Observatory.
Mr. Sidney Edelson, U. S. Naval Observatory.
Mr. Charles Earl Gasteyer, Dearborn Observatory.
Mr. J. M. Grant, Dominion Observatory.
Dr. Weikko A. Heiskanen, Ohio State University.
Mr. Frank John Kerr, Sydney, Australia.
Mr. Charles H. LeRoy, Pittsburgh, Pennsylvania.
Dr. Jack L. Locke, Dominion Observatory.
Mrs. Harriet H. Malitson, Washington, D. C.
Mr. Walter E. Mitchell, Jr., Leander McCormick Observatory.
Mr. Roger Chandler Moore, Flower Observatory.
Mr. Martin E. Nason, Flower Observatory.
Mr. Gordon A. Newkirk, University of Michigan Observatory.
Mr. Frank Quimby Orrall, Harvard College Observatory.

Mr. James M. Parker, Mt. Wilson Observatory.
Miss Helen B. Pettit, Pasadena, California.
Dr. J. A. Rottenberg, Dominion Observatory.
Mrs. Vera Cooper Rubin, Cornell University Observatory.
Mr. John Schombert, U. S. Naval Observatory.
Mr. Raymond A. Spong, New London, Connecticut.
Prof. Harold C. Urey, University of Chicago.

The President then requested those present to stand as a tribute to those members who had died during the past year. The names were read by the Secretary as follows:

George Russell Agassiz.
Leon Campbell.
Curvin H. Gingrich.
Frank S. Hogg
Frank B. Littell.
E. A. Milne.
John Paraskevopoulos.
Newton L. Pierce.
H. B. Rumrill.
F. H. Safford.
Lois Slocum.

The following officers were elected by ballot:

Vice-president: Dr. C. D. Shane.
Secretary: Dr. C. M. Huffer.
Treasurer: Dr. J. J. Nassau.
Representative, National Research Council: Mrs. Charlotte M. Sitterly.
Councilors: Dr. Martin Schwarzchild, Dr. Milton L. Humason, and Dr. S. Chandrasekhar.

Three members were nominated and elected by unanimous vote for the nominating committee, as follows:

Dr. Joel Stebbins, Chairman.
Dr. A. N. Vyssotsky.
Dr. Lyman Spitzer, Jr.

President Joy and Dr. Spitzer discussed the Council action on the two journals. The Society is near an agreement with the *Astrophysical Journal*, but this agreement will be dependent on revision of the by-laws at the Christmas meeting. Last year an information ballot was sent to all regular members of the Society. It is now proposed to have two or three classes of members: 1. Active Members, who will be required to subscribe to one of the two journals. 2. Associate Members, who will not be required to subscribe to a journal, but who will enjoy all other privileges of membership. It is assumed that these members will not be professional astronomers. 3. Sustaining Members, who will pay larger annual dues than the other two classes of members. At the last meeting held in Haverford, Life Memberships were abolished, except for those already in force.

The Washington meeting adjourned at noon on Saturday, June 23. The 86th meeting will be held in Cleveland, Ohio, December 26-29, 1951, to be followed by the 87th meeting in the summer of 1952 (date not yet decided) in Victoria, British Columbia.

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Mr. Frank John Kerr, Sydney, Australia.
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Leon Campbell
1881-1951

By MARGARET W. MAYALL

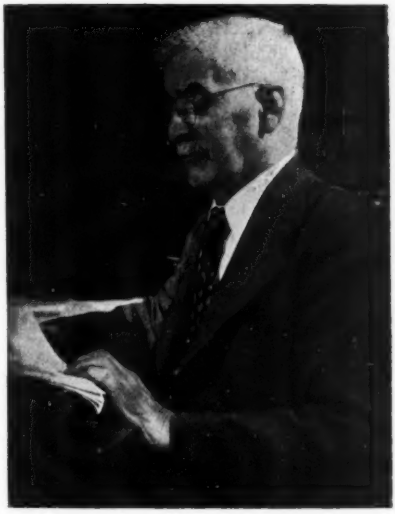
On May 10, 1951, Leon Campbell died. In practically every corner of the world someone feels his passing as the loss of a close friend. For more than 50 years he had been in the enviable position of being able to combine work with a hobby which he considered one of the most fascinating in the world.

In January, 1899, he accepted a position at the Harvard Observatory as assistant to Professor Wendell. For six years he spent every clear night in the dome of the 15-inch, the "Great Refractor," recording the photometric observations Professor Wendell made of the stars, asteroids, and satellites. Cloudy nights and daylight hours were spent reducing the observations and preparing them for publication. In spite of his long hours, Leon found time to make some observations of his own on variable stars. His first observations of Mira Ceti and Chi Cygni were made with naked eye and field glasses, but later he was allowed to take a 5-inch telescope out on the balcony of the dome. This experience undoubtedly enabled him to acquire the fine understanding of the amateur astronomer and his problems which stayed with him throughout his life.

The importance of systematic observations of variable stars was recognized more and more, and in 1905, Mr. Campbell was given the use of the new 24-inch reflector at the Harvard Observatory, to supplement the work being done by Professor Wendell with the 15-inch refractor. Most of the variables had no good comparison stars, and one of his first jobs was the selection and measurement of a sequence for each variable on his list. His work of estimating the magnitudes of variables and the selection of sequences was published in various numbers of the Harvard Annals.

The seed of the idea of the formation of an association of variable star observers was sown in 1910, when Leon Campbell journeyed to Norwich, Connecticut, to instruct William Tyler Olcott in the art of observing. A year later, Mr. Olcott was instrumental in forming the American Association of Variable Star Observers.

From 1911 until 1915, Mr. Campbell was in charge of Harvard's southern station, in Arequipa, Peru. Administrative duties were heavy, and he had four photographic telescopes to be kept in constant operation, but he still found time for some visual work with a 5-inch portable telescope. He kept in close contact with Olcott and the newly formed AAVSO, and helped work out observing programs for the interested amateurs. When he returned to Cambridge in 1915, he was put



LEON CAMPBELL
1881-1951

in charge of the photometric and visual work with the 15-inch equatorial and the 12-inch polar telescopes. Variable stars continued to be his favorite objects for study, and in addition to his thousands of observations, he made critical analyses of their periods and light curves, and published predictions of maxima and minima, for the benefit of other observers. He was never too busy to stop his work and give words of advice and encouragement to amateurs all over the world.

In 1919, Leon Campbell was elected president of the American Assosociation of Variable Star Observers. Several years later he became the recording secretary, and then was given the permanent position and title of Recorder. In 1928, he was appointed instructor in astronomy at Harvard, and in 1931 he was appointed the first Pickering Memorial Astronomer, which position he held until his retirement in 1949. In June, 1949, Harvard honored him with an honorary Master of Arts degree.

Leon Campbell was well known to professional astronomers, but probably his greatest work was as "liaison man" between the professionals and the interested amateurs. Many astronomy clubs were formed under his guidance, and thousands of greater Boston school children and adults visited Harvard Observatory, and had their first glimpses of the fascination of the stars through the kindness of "Mr. Open Nights."

Nearly a million and a quarter observations of variable stars by more than 500 members of the AAVSO were collected and published by Mr.

Campbell. His writings in technical and semi-popular journals numbered well over 1500 separate articles, and he was joint author with Luigi Jacchia of "The Story of Variable Stars," published by Blakiston, 1941 and 1946. When he retired in 1949, he devoted his time to the preparation of a long-deferred volume of mean light curves of about 400 long period variables. This volume will be completed and published before long, and will be a fitting memorial to the man who devoted his life to the study of variable stars.

HARVARD COLLEGE OBSERVATORY, CAMBRIDGE 38, MASSACHUSETTS, JUNE, 1951.

Remarks on Suggested Improvements in Sunrise-Sunset-Twilight Tables

By G. M. CLEMENCE

In the April 1951 number of this Journal Charles H. Smiley suggests certain improvements in the tables of sunrise, sunset, and twilight in ordinary use, which are compiled and published by the Nautical Almanac Office, U. S. Naval Observatory, and H. M. Nautical Almanac Office, Royal Greenwich Observatory, on principles agreed upon by them, under the terms (in the United States) of congressional authorization in 1912. The improvements suggested by Smiley are as follows: (1) that the tables of sunrise and sunset at the surface of the earth should take into account, at least in part, the change in the refraction due to temperature-change in terms of latitude and time of year; (2) that the conventional definitions of the various kinds of twilight should be replaced by others; (3) that the criteria now used for calculating times of sunrise, sunset, and twilight for heights above the surface of the earth should be revised.

It is my purpose in this article to examine and evaluate these suggestions, and it may as well be said at once that the only one I agree with is number (3), as it relates to twilight.

SUNRISE AND SUNSET AT THE SURFACE OF THE EARTH

Here I agree with Smiley's reasoning, but not with his conclusions, which in any case are weakened by a mistake in arithmetic. The calculated time of sunrise or sunset at the surface of the earth is the time when the center of the sun has a true zenith distance of 90° 50′, 34′ being allowed for refraction and 16′ for the semidiameter of the sun. In the tropics the average value of the refraction is less than 34′, and it would be more accurate to take it as 31′, as Smiley says. If this were to be done, then, since the sun rises and sets nearly vertically to the horizon, and moves 3′ in 12 seconds, the calculated time of sunrise would be 12 seconds later than at present, the calculated time of sunset 12 seconds earlier, and the calculated period of sunlight would be shortened by 24 seconds, not 1½ minutes as asserted by Smiley. The times

of sunrise and sunset are, however, calculated only to minutes, not seconds, and the effect would be to leave most of the values unchanged; approximately one out of five of the values given in the present tables would be altered by a minute. I believe that so small an error as 12 seconds in the time of sunrise and sunset is of no practical consequence, and that the labor and expense of calculating separate tables for the tropics would not be justified.

In the polar regions the errors of the present tables are somewhat greater than in the tropics, for two reasons: the refraction departs further from the conventional 34′, and the sun changes its altitude more slowly because its path is less inclined to the horizon. Under extreme conditions, when the sun is just commencing or terminating a period of weeks above or below the horizon, an error of 1′ in the assumed refraction may produce an error of as much as an hour in the time of rising or setting. Nothing can be done to overcome this drawback; the indeterminacy is a geometrical one, and the refraction at any instant may differ by several minutes of arc from the most accurate value that can be calculated. Under average conditions, however, the present tables are accurate to about a minute of time, and I am not aware of any practical need for better ones. In the polar regions, a graphical presentation of the data is more convenient than a tabular one, in any case.

It may be worth mentioning that in the most elaborate tables of sunrise, sunset, and twilight so far published (*Tables of Sunrise, Sunset, and Twilight,* Supplement to the American Ephemeris, 1946) provision is made for correcting the times of sunrise and sunset for departures of temperature and pressure from the standard conditions.

Twilight at the Surface

It is true that the present definitions of twilight are arbitrary. Civil twilight comprises the interval when the true zenith distance of the center of the sun is between 90° 50′ and 96°, nautical twilight between 96° and 102°, and astronomical twilight between 102° and 108°. Civil twilight corresponds very roughly to the interval when ordinary occupations out of doors may be carried on without artificial light, nautical twilight to the interval when both the brightest stars and the sea horizon are visible (the darker limit here is probably closer to 100° than 102°), and the ending of astronomical twilight to the time when no trace of illumination from the sun appears in the sky. Admittedly these descriptions are inexact. Smiley prefers to replace them by others such as "the time when an observer with dark-adapted eyes could see stars of magnitude 5.0," which for purposes of calculation would be translated into some definite zenith distance of the sun. But it is difficult to see how the new definitions would be practically superior to the old ones. Different persons differ considerably in their ability to see stars of magnitude 5.0, the presence or absence of the moon would be an important factor, and the description would mean nothing to persons unfamiliar with the scale of magnitudes, whereas the present descrip-

tions have at least the merit of being generally understandable. The effect of the change would be merely to replace one arbitrary definition by another.

Few if any persons using a table of twilight for the first time have any definite idea what to expect. After a little experience they learn to associate the figures in the table with a certain degree of illumination. Once this has been done (and it must be done in any case) the present table is as useful to them as any other would be. For example, one ship's navigator leaves orders to be called in the morning 20 minutes before twilight, another 30 minutes. One astronomer may begin observing in the evening just as twilight ends, another, who requires a darker sky for his work, may wait a half hour.

In a survey conducted in 1947 with a view to revision of the *American Nautical Almanac*, navigators were asked to check one of the following statements. At the time of beginning or ending of twilight given in the *Nautical Almanac* the sky is (1) too dark. (2) too light. (3) about right, (4) I have no opinion. The total number of replies received to the question was about 1023; 10 per cent voted too dark, 4 per cent too light, 31 per cent about right, and 55 per cent had no opinion. There is no evidence here that the majority of users of the *Almanac* would be pleased with any change.

It is worth noting that nautical twilight was introduced by L. J. Comrie, purely as a convenient subdivision of the more extended period. The name had no significance other than as a convenient label. It was Comrie's intention that each user should determine by experience the particular depression of the sun that corresponded best to his particular requirements, and that he should then interpolate between two of the tabulated twilights.

Sunrise and Sunset at Heights

The conventions now used in calculating sunrise and sunset at various heights above the earth are in fact (contrary to Smiley's belief) closely related to reality. It is true, as he says, that the curvature of the refracted ray is calculated on Ivory's hypothesis regarding the constitution of the atmosphere. These calculations have, however, been compared with others made on various other hypotheses, and no significant differences exist among any of the calculations. Furthermore, the hypotheses have been tested by actual observations of the sun's apparent altitude when it was close to the horizon, and it cannot be doubted that they correspond closely to the actual conditions. Indeed, the assumptions made can hardly lead to errors of more than a minute in the present tables, even under unusual conditions, except in those rare cases mentioned earlier, where a geometrical indeterminacy exists.

Some scientific interest would undoubtedly attach to the results of some of the observations proposed by Smiley, that is, the dip of the horizon at different altitudes, but it is doubtful if they would result in any appreciable improvement in the tables of sunrise and sunset.

BEGINNING OR ENDING OF TWILIGHT AT HEIGHTS

The assumptions on which these tables were calculated have little or no physical foundation, as Smiley remarks. Although they originated with H. M. Nautical Almanac Office, responsibility for their adoption and use is shared equally by the two Nautical Almanac Offices. Like the definitions of twilight at the surface, the assumptions are quite arbitrary. It is assumed that the duration of twilight decreases with increasing heights, falling off to zero at the upper limit of the atmosphere, and that the rate of decrease is greatest near the surface.

As in the case of twilight at the surface, a single table cannot possibly satisfy the requirements of all possible users. The real difficulty is not so much physical and mathematical as practical. Each user of twilight tables at heights is concerned with his own requirements as to visibility. Some are concerned with horizonal illumination, others with sky brightness (which varies greatly, of course, with direction), others with air to air visibility, others with air to ground visibility, and yet others with ground to air visibility. There is no single depression of the sun below the horizon which for a particular height will meet the diverse requirements of all these persons. On the other hand, once a requirement has been formulated, it is not a difficult matter to make the necessary observations to determine the depressions of the sun corresponding to the times at which the specified conditions hold.

Now as in the past, the Nautical Almanac Office stands ready to consult with users of twilight tables regarding their requirements, to assist in planning the necessary observations, and to produce tables embodying the results.

NAUTICAL ALMANAC OFFICE, U. S. NAVAL OBSERVATORY, WASHINGTON, D. C.,
1951 APRIL 11.

Linearity in Photoelectric Equipment

By JAMES CUFFEY

ABSTRACT

An instrument for testing the linearity of photoelectric equipment is described. Five light sources, each provided with a sensitive means for adjustment to equal intensities, are used for determining deviations from linearity over the limited range of intensity corresponding to a single full-scale deflection of the recording meter. For testing over a very wide intensity range, neutral filters of accurately known densities may be used in the instrument.

The tester has been applied to various combinations of three DC amplifiers of the Kron type (AC powered), one single-sided feed-back circuit of the Vance type (battery operated), an Esterline-Angus 0-1 MA recorder, and a Brown Electronik 0-10 MV recorder. In one case, serious deviation from linearity, amounting to three percent was present, but in general the deviations were of the order of 0.5 percent.

It is concluded that for the most accurate work, and for work where linearity over the meter scale is to be relied upon, evaluation of the linearity correction appears to be worth while. In the present investigation, accurately calibrated neutral filters were not available for testing over a wide range of intensity. However, observations of the photovisual magnitudes of the North Polar Sequence stars furnished a satisfactory check on linearity over the wider intensity range.

A given combination of photoelectric equipment is linear if

$$D = k\,I$$

where k is a constant, and D is the recorder deflection produced by light of intensity I falling upon a fixed and limited area of the sensitive surface of a phototube for the time interval customarily employed in making the readings. In practice, most photoelectric equipment is remarkably linear in spite of numerous electronic components of only commercial, rather than ideal, accuracy. This may be the reason for the prevalent feeling that any piece of photoelectric equipment may be assumed linear without necessity for testing. Of the three components of photoelectric equipment, namely, the photomultiplier tube, the direct current amplifier, and the recording meter, only the phototube itself is a highly linear device by its very nature. The amplifier and recording meter are necessarily limited in linearity by commercial considerations and the expense involved in obtaining perfect electron tubes, resistors, and other commercially available parts. That the equipment turns out to be so nearly linear in practice is due to the smallness of the photo-currents being measured, to the very small demands for power output put on the amplifier by the recorder, and to the use of very large values of the plate load resistors (3 megohms) in the amplifier. It is, however, extremely desirable to have a convenient testing device which will show up lack of linearity in the equipment when tested as a working unit under circumstances similar to those encountered during actual use.

In operation on a given sensitivity setting, the photo-current fed to the amplifier is capable in general of propelling the recorder indicator over a single full-scale deflection. The first aspect of linearity testing, therefore, concerns the linearity of the combination of amplifier and recorder over the limited intensity range corresponding to a single full-scale deflection. Since the calibration of the amplifier sensitivity steps can be made without additional testing equipment, by using ratios of deflections measured with the recorder itself, this aspect of linearity testing is of primary importance. The second aspect of linearity testing appears when the amplifier operates at many different levels of sensitivity, and the properties of the electrical circuit may be altered slightly by the extremely wide range of resistance and capacitance employed in the input circuit. It is therefore also desirable to test for linearity over a wide range in light intensity.

The linearity tester in use at the Goethe Link Observatory (see

Figure 1 and Figure 2) provides a convenient method of testing both aspects of linearity, and has proven its value in testing four different amplifiers used at the telescopes of the Goethe Link Observatory. The tester consists of a light-tight box 20 inches long with an inside cross section measuring 4 x 5 inches to permit the use of 4 x 5 diffusing screens and photographic neutral filters. At one end of the box are five light sources powered by five heavy-duty dry cells in parallel. The 2.2 volt lens-type Mazda flashlight bulbs were found suitable. Each bulb is mounted in a light-tight compartment provided with two independent shutters. The first shutter is a wedge-shaped aluminum slide which regulates the intensity of the light from the bulb. The second shutter immediately in front of the first is a light-tight cut-off shutter. Three sheets of flashed opal glass distributed along the box eliminate directional effects, and a long tube near the photometer limits its field of vision to approximately that which it experiences when in use on the thirty-six-inch reflector. Two shutters appear near the end of the tube, the first being a wedge-shaped slide used to regulate the amount of light reaching the photometer, and the second, a cut-off shutter.

In use, the tester relies for its accuracy upon the fact that the individual lights can be adjusted to equal intensities by the use of the adjusting shutters and sufficient amplifier gain to give nearly full-scale deflection of the recording meter. Since the individual lights can be

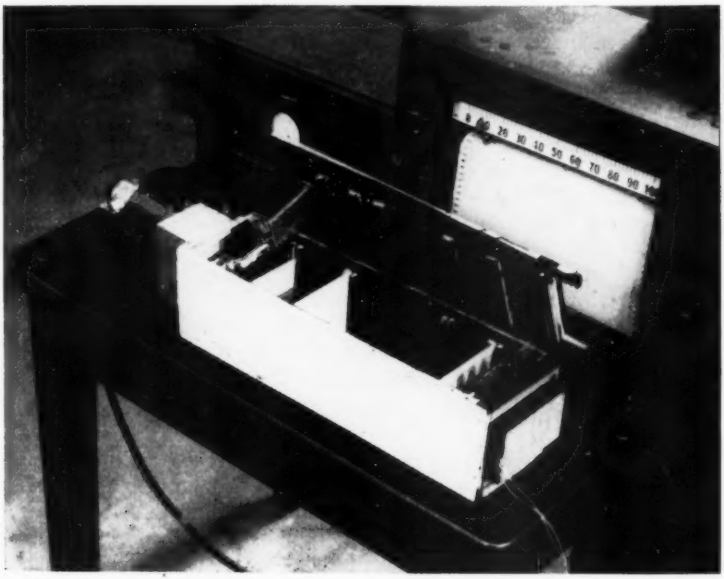


FIGURE 1

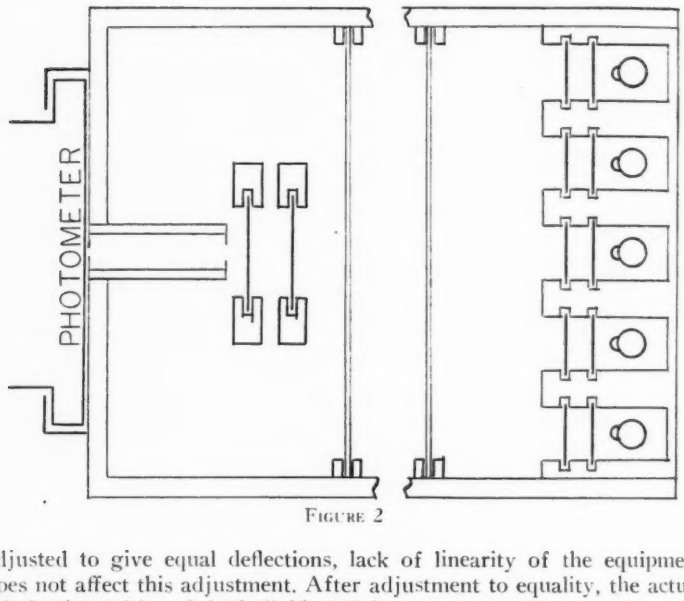


FIGURE 2

adjusted to give equal deflections, lack of linearity of the equipment does not affect this adjustment. After adjustment to equality, the actual relative intensities of the individual lights are measured, using the averages of several readings symmetrically arranged and timed so as to be independent of the slow downward drift due to battery aging. These values are used in the reductions and are correct to a high degree of accuracy unless the recording meter is quite abnormally non-linear. All five cut-off shutters are then opened, and the wedge at the photometer end of the box is adjusted so that the sum of the intensities gives full-scale deflection. The cut-off shutters are then closed or opened successively so that their individual intensities may be added to give known intensities at five points on the scale. These intensities are then compared with the observed deflections to obtain the linearity correction. Once more, of course, suitable precautions must be observed in arranging the deflections symmetrically in time so that the aging of the batteries powering the lights does not affect the results.

The testing procedure described has been applied to three amplifiers of the Kron type (*Electronics*, **21**, p. 103, Aug., 1948), and one of the single-sided feed-back type of A. W. Vance (*Rev. Sci. Instruments*, **7**, 489-493, 1936, and see also "Photoelectricity," by Zworykin and Ramberg, John Wiley and Sons, p. 228). Three 1P21 photomultiplier tubes and two recorders, the Esterline-Angus 0-1 MA and the Brown Electronik 0-10 MV, were used in various combinations. It was found that a very desirable modification, suggested by Mr. George F. Siddons, could be made in the Kron amplifier circuit. A means was provided for

balancing the filament currents in the 9001 tubes through adjustment of a 10-ohm rheostat. One side of the 6-volt filament supply was connected to one side of each of the filaments. The other side of the 6-volt supply was connected to a 3.25-ohm resistor in series with the arm of the rheostat. The two ends of the rheostat resistance were then connected to the two remaining filament terminals of the 9001's. It was then possible to make use to some extent of unselected tubes and to adjust their transconductances to equality by adjusting the cathode temperature to vary the electron emission. In use, the rheostat is regarded as a drift control, and is adjusted until the slow drift, normally encountered if one does not use tubes selected with great care, disappears. An additional comment of interest here is that the steadiness of the amplifiers improved greatly during the first three months of operation; they were left continually turned on.

The results of some of the tests are shown in Figure 3. (A) shows

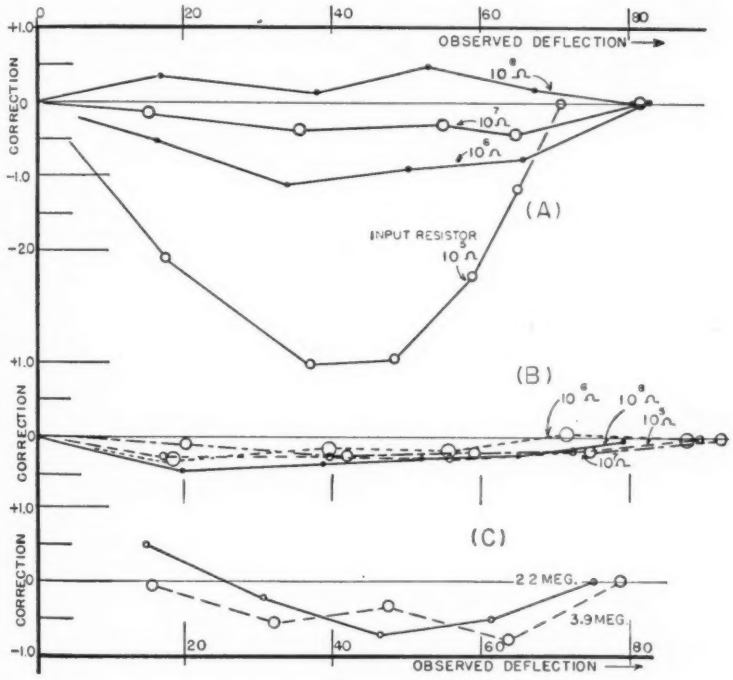


FIGURE 3

the linearity corrections for Amplifier No. 1 used with the Brown recorder. Further tests showed that the recorder was not to blame for the lack of linearity and that the source of trouble lay in the wiring of the

input to the amplifier. At that time this consisted of a single time-constant capacitor across the input to the grid resistor, and the grid of the first tube received its signal from one of the taps of the coarse sensitivity step resistor. The linearity was greatly improved when the input circuit was rewired so that each input grid resistor had its own time-constant capacitor, and the linearity corrections then resembled those shown in (B). Figure 3 (B) shows the linearity corrections for Amplifier No. 2, used with an Esterline-Angus recorder, and corrections of this approximate magnitude were found for the other Kron type amplifiers. Additional data, not presented here, indicate that the recording devices are satisfactorily linear; in other words the Esterline-Angus, and Brown Electronik meters, when used with the Kron circuit with appropriate series and shunt resistors, are interchangeable and capable of work of high precision. Figure 3 (C) shows the linearity corrections necessary for the single-sided feed-back amplifier of the Vance type used with the Brown recorder. All deflections were of 20 seconds duration and the time constants of the input grid circuits in most cases approximately one second. A yellow filter was used in all cases to minimize errors due to varying color temperatures of the bulbs.

The linearity tester used in the above measures is readily adapted to testing over a wide intensity range if one has access to accurately calibrated neutral filters. Such filters could be calibrated by use of the photoelectric equipment itself after the short-range linearity corrections have been determined and use made of the procedure of varying the distance from a light source to the photometer. For accurate calibration of the neutral filters by this method, one requires a fairly long and completely darkened room, which may not be conveniently available. Once the neutral filters have been calibrated by the inverse square law, however, they could very conveniently be used in the tester to determine linearity corrections as a function of light intensity, to supplement those which are a function of the position of the indicator on the meter scale. At present our facilities for using the inverse square law have been found inadequate for calibrating the neutral filters, and we have used observations through a yellow filter of the North Polar Sequence stars to confirm the linearity of our equipment over the range of intensities encountered in the photometric work on the star clusters. The International Photovisual magnitudes, as revised by Seares and Joyner (*Ap. J.*, **101**, 15, 1945) were used, and appropriate corrections for atmospheric extinction were made. The results of these tests indicate very good linearity, in spite of the scatter in the existing values of the magnitudes.

The author expresses his appreciation to Dr. John B. Irwin, and to Mr. George F. Siddons for many discussions of the problems which arose during the investigation, and to Mr. A. N. Cox and K. P. Hallam for assistance with the measurements and reductions.

Goethe Link Observatory, Indiana University, Bloomington, Indiana, March 2, 1951.

The Solar Faculae

By H. B. RUMRILL*

If the opening sentence of the chapter on the Sun, in Webb's "Celestial Objects for Common Telescopes"—"The solar phenomena are especially wonderful"—were taken to apply particularly to the faculae, it would be as well within the bounds of veracious description.

These "little torches," resembling molten metal, possess many characteristics observable to good purpose with small telescopes. Usually seen at their best when within, say, a hundred thousand miles or so of the limb, their area is frequently some billions of square miles in a single group, with variations of brilliancy often strikingly obvious, accentuated by the gradual decrease of photospheric light toward the circumference. Branching tongues of incandescence, outshining the photosphere, are mingled with irregular masses of lesser brightness, at times comparable to the flocculent appearance of a mackerel sky reflecting the radiance of the rising sun, when terrestrial clouds are low-lying; or, quoting Young's apt illustration, "looking much like the flecks of foam which mark the surface of a stream below a waterfall." ("The Sun," p. 106.)

Possibly the faculae may be considered as of peculiarly cloud-like nature, more so than the photosphere, and something of similarity to our own cloud formations, although at vastly greater heights, impresses the solar observer whose principal interest may be the counting of the spot groups and their content—wherein a telescope of moderate size also excels.

As with viewing cloud scenery, in which a lightly tinted shade glass develops detail, a good deal depends on the color and consistence of the screen attached to the eyepiece. Where greenish-yellow serves well in studying spot structure, a truly neutral "London smoke" tends to bring out the faculae detail with increased distinctness. But "London smoke" glass varies in color as well as density, and repeated trial may be necessary to determine the kind most suitable.

An invaluable accessory is the Herschel wedge prism, preferably so mounted as to permit ready blending of filter colors. It is a very nice matter to select the right depth of shade, for instance as between gazing at the Sun when near the horizon, and in or near the meridian. The sliding wedge screen, with its admirable gradation of absorption, is doubtless the most practicable method of adapting color and density to light values and atmospheric conditions, especially in critical examination—its combination with the Herschel device ideal for eye protection and discriminative study. The one I use, made by Zeiss, is very satis-

*Died January 23, 1951.

factory, as placed over the eye-lens of an "orthoscopic" ocular, which has a longer eye distance than most other eyepieces.

Where sketching the positions and forms of spot groups offers no great difficulty, it is quite the opposite to attempt drawings of the faculae groups with any approach to exact delineation, as it is seldom that their outlines are sufficiently definite, causing any picturing thus to be only approximately accurate.

Although associated with the spots ("maculae") as a general thing, the faculae often appear beyond the belts of spot formation, occupying narrow regions contiguous to the limb, but are then much less prominent. One of the grandest of solar spectacles is the occasional massing of spots in a group of immense spread, surrounded or overlaid by still more extensive patches of faculae, whose intense luminosity makes their blackness yet deeper notwithstanding inherent brightness—through enhanced contrast.

Commonly the faculae are confined to the spot zones, and their apparition at either limb indicates affinity with the spot groups, such connection further evidenced by the views taken with the spectroheliograph in the light of calcium vapor. However, the faculae are frequently visually apparent at considerable distances from either limb and are sometimes seen attending spot groups far inside the limbs and not touching thereat. In the finest of solar definition, when the photospheric granulation is plain, the faculae are often conspicuous, although lacking the sharp contours of spot umbrae and penumbrae—this alone attesting difference of physical character. Where the spots presumably have their origin within the cooler depths of the photosphere, the very luster of the faculae may arise in part from the greatly higher temperatures of gases of lesser density in a state of combustion excessively beyond the heat at the photospheric level.

While the spot groups are almost without exception to be found within the limitations of the Sun's temperate zones, and of its upper and lower torrid zone (if such terms may be used where all is torrid to an unimaginable degree), as stated above the faculae extended, but with diminishing distinctness, adjacent to the limb toward the poles, and are therefore not entirely a concomitant of the maculae, but also of the prominences. Oftentimes I have been able to detect numerous dissociated masses of faculae of vague consistence, reaching much higher northern and southern latitudes, but because of the latter characteristic it is extremely difficult to indicate more than their existence in drawings. Just as often nothing of such phenomena can be seen; possibly the unknown cause of the cycle periods has something to do with the variations of visibility. Uncertain seeing may result in a dubious merging of photosphere and faculae, making it impossible to distinguish the one from the other, and mere increase of magnification does not provide a solution.

When, however, the seeing is above par, as often occurs in mid-

morning and mid-afternoon, due largely to aerial quietude in locations removed from artificial disturbance of the atmosphere, the solar faculae are sometimes surprisingly well defined, but I have not found the observing opportunities so presented of long duration. It takes very little to restore the more common condition arising from the constant turmoil of air currents at the varying heights of wind pressure and direction—taxing the most philosophic patience while awaiting moments of good vision through the telescope.

The glowing clouds of faculae vary as well in transparency, or rather translucency, as indicated by the changing visibility of the smaller spots when nearer the limbs. Probably this is one of the reasons why such spots disappear and reappear, subsidence and emergence through the photosphere itself not being altogether accountable for these phenomena. In watching the progress of spot groups with the solar rotation, it often happens that small spots do not retain visibility to the edge of the western limb, and frequently become visible similarly some distance from that of the eastern limb, to be reckoned as "new." Time and again a mass of faculae comes into view at the eastern limb, the harbinger of a spot or spots seemingly hidden at first within its embrace.

The appearance is that of emergence through faculae and photosphere in the latter event, and in the former one of subsidence within their depths, emphasized by the greater thickness of the solar atmosphere with its angular perspective or "foreshortening." It is in such observations as these that visual perception of details, if on the verge of discernment at all, is aided by the finest instrumental means as adjuncts of a perfect object glass.

Because of the conditions cited herein it is not easy to determine whether the faculae, like the spots, have, with their inferior stability, something of proper motion, but this would seem to be among their characteristics, probably to a greater extent than the spots. Lengthy observation may be required to ascertain this as a normal fact, and whether the reasons for the proper motions of both are identical, resting on displacements of the photosphere. The likelihood of this being the case rests in turn on the mobility of all solar phenomena and their general relationship.

Not to be overlooked is that, even with the most powerful modern instruments, we are really dealing microscopically with features of stupendous magnitude, seen at best as if no nearer than the Moon's distance from the Earth. There is little or nothing analogous to aid our understanding of the meaning of much that is constantly transpiring at the source of energy of the System; but on the other hand we may credibly suppose that multitudes of remote suns, the stars, follow the same general pattern, including the phenomena of faculae whose brilliance must be similarly greater than that of the surface of which they are a part. Can this contribute to a status of variability?

And the student of solar physics must not ignore the records of the

past as embodied in the works of well-known specialists on the subject in endeavoring to learn more of the significance of the faculae and of their place in the ensemble of the Sun's "especially wonderful phenomena."

TREDYFFRIN OBSERVATORY, BERWYN, PENNSYLVANIA.

Contributions of the Meteoritical Society

Edited by FREDERICK C. LEONARD
Department of Astronomy, University of California, Los Angeles 24

Constructional Names and Symbols for the Subclasses in the Simplified Classification of Meteorites*

FREDERICK C. LEONARD
Department of Astronomy, University of California, Los Angeles 24

ABSTRACT

Constructional names and symbols for all 32 of the subclasses of meteorites recognized in the simplified classification are given. These names and symbols indicate, in each case, the general structure and mineral composition of the comprized meteorites. The paper contains 4 tables: (1) 20 qualifying symbols or qualifiers; (2) symbols for the 16 minerals commonly occurring in meteorites; (3) symbols for 24 other minerals found in meteorites; and (4) the 32 subclasses of meteorites and their symbols. Some 13 subclasses that have been excluded from the simplified classification, and both "composite" and "transitional" meteorites are condensedly discussed. Finally, the classificational sequence of meteorites, which is a sequence primarily of increasing density from left to right, is written out, in terms of the new constructional symbols, for all 32 of the subclasses in the simplified classification, and the sequence is briefly reviewed.

"A Simplified Classification of Meteorites and its Symbolism" were described in a paper bearing that title, which appeared in *C.M.S.*, **4**, 141-6; *P. A.*, **56**, 437-42, 1948, and to which reference should be made in connection with the present paper. In the simplified classification, meteorites (symbol = MI) are partitioned first into the 3 grand *divisions* of aerolites (AE), siderolites (SO), and siderites (SI),[1] which, in turn, are differentiated into 7 *classes*, thus:

AEROLITES (AE)	{ Achondrites (A)†
	{ Chondrites (C)
SIDEROLITES (SO)	{ Sideraerolites (S)
	{ Lithosiderites (L)
SIDERITES (SI)	{ Hexahedrites (H)
	{ Octahedrites (O)
	{ Ataxites (D)

*Read at the 14th Meeting of the Society, Los Angeles, California, 1951 June 18-19.

†Distinguished into calcium-rich or non-ferriferous achondrites (A_1) and calcium-poor or ferriferous achondrites (A_2).

The single-capital-letter symbol for the class constitutes the primary part of the symbol for each *subclass* thereunder, so that the *class* to which a meteorite belongs is evident by mere inspection of the symbol for the subclass of the meteorite; and as many of the following (*v.* Table 1) *qualifying symbols* or *qualifiers—i.e., parenthesized*, single

TABLE 1. QUALIFYING SYMBOLS OR QUALIFIERS

The type (or types) of meteorite to which each qualifier is applicable is (or are) indicated in parentheses, after the definition of the qualifier.

(a)—grained or granular (siderites only)
(b)—brecciated (aerolites only; chondrites usually; achondrites occasionally)
(c)—spherical or spherulitic (chondrites only)
(e)—fused (octahedrites only: (e) = octahedral "figures disordered by fusion")
(f)—{ fine (octahedrites only) / friable (aerolites only)
(ff)—finest (octahedrites only)
(g)—{ coarse (octahedrites only) / gray (chondrites only)
(gg)—coarsest (octahedrites only)
(i)—intermediate (chondrites only)
(k)—crystalline (chondrites only)
(m)—medium (octahedrites only)
(n)—having (or with) atypical inclusions* (any kind of meteorite having such inclusions)
(o)—oxidized† (any kind of *terrestrially* oxidized meteoritic matter)
(p)—peculiar or atypical (any kind of meteorite having peculiar or atypical features)
(r)—carbonaceous (chondrites only)
(s)—black (chondrites only)
(t)—terrestrialized† (any kind of *terrestrialized* meteoritic matter)
(u)—vitreous‡ (aerolites only)
(v)—veined (any kind of veined meteorite: chondrites usually)
(w)—white (chondrites only)

NOTES TO TABLE 1

*Presumably of nickel-iron for aerolites (mainly calcium-poor or ferriferous achondrites, A_2) and of silicates for siderites. The *specific* composition of the inclusions may be indicated by adding the appropriate mineral symbol (or symbols) (Tables 2 and 3, *post*) as a subscript (or subscripts) to the qualifier; *e.g.*, (n_i), (n_o), and (n_{eo}) are the symbols for inclusions of nickel-iron, of olivine, and of olivine-enstatite, respectively.

†*Cf. C.M.S.*, **5**; *P. A.*, **59**, 212-13, Apr., 1951.

‡(t) stood originally for "vitreous," but shall be used henceforth for "terrestrialized," whereas (u) shall be employed for "vitreous"—a qualification rarely encountered.

(or, in 2 cases, double, namely, (ff) for "finest" and (gg) for "coarsest"), lower-case letters—as may be required to complete the classification of a specimen are suffixed to the symbol for the division, the class, or the subclass.[2] Table 1 of the current paper is a revised list of the qualifying symbols or qualifiers. This table contains all of the original qualifiers and a few additional ones, and brings their number to 20.

Table 2 of the earlier paper, entitled "Subclasses of Meteorites and their Symbols," gave the new and old symbols and the names for some 41 subclasses of meteorites, of which 29, exclusive of calcium-rich and calcium-poor achondrite (A_1 and A_2, respectively) and "pallasite, not

further classified," could be regarded as distinct. These names are, however, for the most part, the names employed both in the inadequate and obsolescent Rose-Tschermak-Brezina classification,[3] and in the more recent and much improved classification of G. T. Prior,[4] which has been followed in this paper as the principal authority on the mineral composition of meteorites. Many of these old subclass names have been derived from the names of persons (*e.g.*, "chladnite" and "pallasite") or of places (*e.g.*, "aubrite" and "sherghottite") or from certain more-or-less superficial characteristics of the specimens themselves (*e.g.*, "amphoterite" and "eukrite"), and so convey no real information about the structure and/or the composition of the meteorites to which they have been applied. In an attempt further to simplify, rationalize, and regularize the classification of meteorites, names and symbols have been given the various subclasses that are in each case indicative of the structure and composition of the included meteorites. It is a rather remarkable (and, for the non-mineralogist, a very fortunate!) fact that all of the recognized varieties of meteorites are made up substantially of one or more of the 16 minerals enumerated in Table 2. In this table,

TABLE 2. SYMBOLS FOR THE MINERALS COMMONLY OCCURRING IN METEORITES*

a—anorthite
b—bronzite
b′—clinobronzite
d—diopside
e—enstatite
h—hypersthene
h′—*clinohypersthene*
i—nickel-iron (or kamacite, taenite, & plessite *collectively*: "the trias")
k—kamacite
l—oligoclase
m—maskelynite
o—olivine (or chrysolite)
p—plessite†
r—tridymite (or asmanite)
t—taenite
u—augite

NOTES TO TABLE 2

*Minerals whose names are *italicized* in Tables 2 and 3 are, according to George J. Neuerburg (*C.S.R.M.*, **3**, 255-8; *P. A.*, **54**, 248-52, 1946; and *C.M.S.*, **4**, 202-3; *P. A.*, **57**, 342-3, 1949), exclusively, or probably exclusively, meteoritic in their occurrence.

† Plessite is not technically a mineral, but is rather an intergrowth of kamacite and taenite, usually on a microscopic scale.

a single, lower-case letter is used as the symbol for each of these 16 common meteoritic minerals. In Table 3, symbols for some 24 less common meteoritic minerals are provided, for possible future use, in the description and classification of meteorites. In Table 3, it has been necessary to introduce, as mineral symbols, 14 lower-case Greek letters as well as 10 more Roman ones. The 40 minerals, for which symbols are supplied in Tables 2 and 3, are all of the minerals that are now known to occur, to any considerable extent, in meteorites.

It is proposed that, henceforth, in the simplified classification, all personal, place, and other infelicitous if not meaningless names and symbols for subclasses of meteorites shall be discarded, and that these shall be superseded by names and symbols that are in each case indicative of the general structure and mineral composition of the contained

TABLE 3. SYMBOLS FOR OTHER MINERALS OCCURRING IN METEORITES*

c—cohenite
e'—*clinoenstatite*
f—forsterite
g—magnetite
n—hedenbergite
[P]—*phosphorus*†
q—quartz
s—*schreibersite*
w—*weinbergerite*
y—troilite (or pyrrhotite)
α—apatite
β—breunnerite
γ—graphite
δ—diamond
ε—*merrillite*
η—*daubréelite*
κ—*kosmochlor*
λ—lawrencite
μ—moissanite
π—plagioclase (other than anorthite (Table 2), or not further identified)
ρ—*rhabdite*‡
σ—*osbornite*
χ—chromite
ω—*oldhamite*

NOTES TO TABLE 3

Cf. n. (*) to Table 2, *ante*.

†The symbol for a *chemical element* not possessing any other mineral name (such as, *e.g.*, "graphite") and occurring in a meteorite shall be the *chemical symbol* for that element, *inclosed in brackets; e.g.*, [P] for phosphorus, [Fe] for iron, [Ni] for nickel, [Co] for cobalt, *etc.*

‡"Rhabdite" is a term applied to schreibersite when it occurs in the form of the minute structures known as "rhabdites."

meteorites. These new names and symbols are called *constructional names and symbols*. In Table 4 are listed all of the subclasses of meteorites, together with their symbols, that are now recognized in the simplified classification—some 32 subclasses in all. In the first 2 columns are given the original name (alphabetically) and symbol for each subclass, and, in the last 2 columns, the proposed new constructional name and symbol. The constructional name for a subclass[5] consists of the name for the class preceded by the names of the most predominant minerals, not already mentioned in the name for the class (*e.g.*, *sider*aerolite and litho*sider*ite) and not exceeding 3, that occur in representatives of the subclass, the mineral names being specified, from left to right, in the order (ideally) of increasing abundance of those minerals in the representatives; and the constructional symbol for a subclass[5] consists of the symbol for the class followed by the symbols for the aforesaid minerals (Table 2), affixed, from left to right, in the order of decreasing abundance of those minerals in the meteorites.[6] Any qualifications (Table 1) that may be needed to complete the classification of a specimen may be made to modify the name for the category (*i.e.*, the division, the class, or the subclass) to which the meteorite belongs, and the corresponding qualifiers may be appended to the symbol for that category (*e.g.*, "crystalline oligoclase-enstatite chondrite"; symbol = Cel(k)).

The 5 chondritic subclasses: ngawite, ornansite, orvinite, rodite, and tadjerite, and the 6 octahedritic subclasses: Copiapo, Hammond, Kodaikanal, Netschaëvo, Zacatecas, and Zacatecas-N'Goureyma (or N'Goureyma), which are included in the Rose-Tschermak-Brezina classification, have been excluded from the simplified classification for the reasons stated in the original paper on the latter classification; moreover,

TABLE 4. THE SUBCLASSES OF METEORITES AND THEIR SYMBOLS

Original Name	Original Symbol	Constructional Name	Constructional Symbol
Amphoterite	Am	Olivine-hypersthene (Ca-poor) achondrite	A_2ho
Angrite	A or An	Augite (Ca-rich) achondrite	A_1u
Ataxite, intermediate = metabolite	D_3	Plessite-kamacite ataxite[1]	Dkp^1
		Kamacite-plessite ataxite[1]	Dpk^1
Ataxite, Ni-poor	D_2	Kamacite ataxite[2]	Dk^2
Ataxite, Ni-rich	D_1	Plessite ataxite[3]	Dp^3
		Taenite-plessite ataxite[4]	Dpt^4
		Plessite-taenite ataxite[4]	Dtp^4
		Taenite ataxite[5]	Dt^5
Aubrite	Au	Enstatite (Ca-poor) achondrite	A_2e
Bustite = aubrite, *q.v.*	Bu		
Chassignite	Cha	Olivine (Ca-poor) achondrite	A_2o
Chladnite	Chl	Hypersthene (Ca-poor) achondrite	A_2h
Chondrite, bronzite-olivine	Cbr	(Olivine-)bronzite chondrite	Cbo
Chondrite, enstatite	Cen	Enstatite chondrite	Ce
Chondrite, enstatite-anorthite,* crystalline	Cek	Crystalline oligoclase-enstatite chondrite	Cel(k)
Chondrite, hypersthene-olivine	Chy	(Olivine-)hypersthene chondrite	Cho
Chondrite, olivine-enstatite	Ceo	Olivine-enstatite chondrite	Ceo
Diogenite = chladnite. *q.v.*	Di or Dio		
Eukrite	Eu	Anorthite-clinohypersthene (Ca-rich) achondrite	$A_1h'a$
Grahamite = mesosiderite, *q.v.*	Mg or Msg		
Howardite	Ho	(Anorthite-)clinohypersthene-hypersthene (Ca-rich) achondrite	$A_1hh'a$
Lodranite	Lo	(Olivine-)bronzite siderae rolite	Sbo
Mesosiderite	M or Ms	(Olivine-anorthite-)hypersthene siderae rolite	Shao
Metabolite = ataxite, intermediate, *q.v.*	D_3		
Nakhlite	Na or Nk	(Olivine-)diopside (Ca-rich) achondrite	A_1do
Nortonite†	A_2no	Olivine-enstatite (Ca-poor) achondrite	A_2eo
Octahedrite, coarse	Og	Coarse octahedrite	O(g)‡
Octahedrite, coarsest	Ogg	Coarsest octahedrite	O(gg)‡
Octahedrite, fine	Of	Fine octahedrite	O(f)‡
Octahedrite, finest	Off	Finest octahedrite	O(ff)‡
Octahedrite, medium	Om	Medium octahedrite	O(m)‡
Pallasite§	P§	Olivine lithosiderite§	Lo§
Sherghottite	She	Maskelynite-clinohypersthene (Ca-rich) achondrite	$A_1h'm$
Siderophyre	Si or Sy	(Tridymite-)bronzite lithosiderite	Lbr
Ureilite	U or Ur	(Olivine-)clinobronzite (Ca-poor) achondrite	$A_2b'o$

NOTES TO TABLE 4

Numbered Notes to the Subclasses of Ataxites

[1] Ni content about 6% to 14%; to be classified as Dkp or Dpk according as kamacite (k) or plessite (p) is the more predominant mineral.

[2] Ni content less than about 6%.

[3] Ni content about 14% to 18%.

[4] Ni content about 18% to 27%; to be classified as Dpt or Dtp according as plessite (p) or taenite (t) is the more predominant mineral.

[5] Ni content greater than about 27%.

(*Cf.* Stuart H. Perry, *op. cit.*, ref. (8), *post*, pp. 45-8 and Fig. 8, p. 48, in regard to the Ni percentages specified in the preceding notes.)

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*"Really oligoclase" (G. T. Prior, *Min. Mag.*, **19**, 60, n. (2), 1920).

†Named for the Norton County, Kansas-Furnas County, Nebraska, fall of 1948 February 18, which has been classified by Carl W. Beck and Lincoln LaPaz (*C.M.S.*, **4**, 176-9; *P.A.*, **57**, 85-8, 1949; and *Am. Mineralogist*, **36**, 45-59, 1951) as indicated in the third and fourth columns.

‡Instead of the symbols O(gg), O(g), O(m), O(f), and O(ff), symbols such as Oktp, in which the mineral symbols k, t, p (Table 2) follow the class symbol O in the order of decreasing abundance of the 3 minerals kamacite (k), taenite (t), and plessite (p) in an octahedrite, could, of course, be employed.

§The 4 varieties of pallasites recognized in the Rose-Tschermak-Brezina classification, namely, the Bitburg or Albacher type (original symbol, Pb = PB or Pa), the Imilac type (Pi = PI), the Krasnojarsk type (Pk = PK), and the Rokicky type (Pr = PR), may, if future investigation proves them to be really distinct subclasses, be assigned the new symbols Lo(B), Lo(I), Lo(K), and Lo(R), respectively, in which the parenthesized initial letters are of the nature of "proper-name" qualifiers (*cf.* Table 1).

the subclass howarditic chondrite (*not* to be confused with the subclass *howardite* = (anorthite-)clinohypersthene-hypersthene (Ca-rich) achondrite; constructional symbol = $A_1hh'a$) has been eliminated from the simplified classification, because every so-called howarditic chondrite is readily classifiable in terms of its mineral composition, in accordance with the present system; furthermore, the subclass cumberlandite or whitleyite (original symbol = Cu or Wht) has been dropped from this classification, because that subclass is, according to the description of its archetype and only known example, Cumberland Falls, Whitley County, Kentucky, not really a subclass, but rather a "composite," *i.e.*, a combination of 2 subclasses, the prototype having been described as "a breccia consisting of fragments of white aubrite (*enstatite achondrite*) and black *enstatite chondrite*" (italics mine), to which the compound symbol, $(A_2 + C)e$, is assigned in the simplified classification. Any other meteorites that exhibit the characteristics of 2 (or theoretically more) distinct subclasses should be classified as composites, and should be given compound symbols accordingly; *e.g.*, some of the Brenham Township, Kiowa County, Kansas, meteorites are in part olivine lithosiderites (or so-called "pallasites") and in part medium octahedrites; hence, those specimens could be denominated "lithoöctahedrites," and should carry the compound symbol Lo + O(m).[7]

Meteorites that are "transitional" in type between 2 contiguous subclasses or classes in the classificational sequence (*post*)—*i.e.*, those that display the characteristics of 2 such categories—may be accorded such

symbols as H(a)-O(gg) (the symbols being *hyphenated*), or simply H-O; O(ff)-Dp, or merely O-D; O(gg-g); O(m-f); *etc.* Not a few siderites are what could be termed either "hexaoctahedrites" (symbol = H-O) or "octahedrataxites" (symbol = O-D).[8]

The difference between a "composite" and a "transitional" meteorite should be emphasized. If a meteorite is "composite," such as Cumberland Falls (symbol = $(A_2 + C)e$) or a few of the Brenham Township specimens (symbol = Lo + O(m)), part of its mass is classifiable under one subclass and part under another, the 2 subclasses in question being not necessarily next to each other in the classificational sequence (*post*), whereas, if the specimen is "transitional," it exhibits thruout its entire body, more or less homogeneously, the characteristics of 2 adjoining subclasses, like, *e.g.*, Santa Luzia de Goyaz, Goyaz, Brazil (symbol = O(gg)-H(a)) and Monahans, Ward County, Texas (symbol = Dp-O(ff)).[9]

Finally, in view of the foregoing discussion, the classificational sequence of meteorites,[10] which, as has been remarked,[11] is a sequence primarily of increasing density (specific gravity) from left to right, may be written out, in terms of the new constructional symbols, for all 32 of the subclasses of meteorites in the simplified classification. This very fundamental sequence follows:

$$\{A_1hh'a\text{—}\begin{matrix}A_1h'a\\A_1h'm\end{matrix}\text{—}A_1do\text{—}A_1u\text{—}A_2o\text{—}A_2h\text{—}A_2ho\text{—}A_2b'o\text{—}\begin{matrix}A_2e\\A_2eo\end{matrix}\}\text{—}\{Shao\text{—}Sbo\text{—}Lbr\text{—}Lo\}\text{—}$$

$$\{H\text{—}O(gg)\text{—}O(g)\text{—}O(m)\text{—}O(f)\text{—}O(ff)\text{—}Dp\text{—}Dpt\text{—}Dtp\text{—}Dt\}.$$

(Cho, Clo, Ce, Cel(k), Ceo; Dk, Dkp, Dpk)

In this device, the symbols for the subclasses under each of the 3 *divisions* of meteorites, aerolites (AE), siderolites (SO), and siderites (SI), are inclosed in *braces;* those for subclasses that are so closely related that they occupy practically identical positions in the sequence are columned; and those for subclasses that comprize meteorites having similar mineral compositions and about the same density, but different structures, are joined by vertical line-segments. It will be observed that the sequence of the ataxites (D) first parallels that of the hexahedrites (H) and octahedrites (O)—just as the sequence of the chondrites (C) parallels that of the calcium-poor achondrites (A_2)—and then runs out uniquely to the end of the entire sequence.

NOTES AND REFERENCES

[1] Meteorites can, almost as satisfactorily, be classified initially under the 2 great *groups* of STONES (symbol = ST) and IRONS (symbol = IR), if it be understood that the stones end with the sideraerolites (class S, *post*) and the irons begin with the lithosiderites (class L, *post*).

[2] Originally a *comma* was used to separate the qualifier or qualifiers from the main part of the classificational symbol, but, since lower-case letters are employed also as *mineral symbols* (*v.* Tables 2 and 3, *post*), qualifiers should henceforth be *parenthesized,* in order to forestall any possible confusion between them and mineral symbols; 2 or more qualifiers should, however, be inclosed in the *same* pair of parentheses; thus (to take an extreme case), C(gkvb) is the symbol for a "brecciated veined crystalline gray chondrite." Seldom are more than 2 qualifiers required to describe or classify a specimen; they should be used sparingly, always, for they play the least significant role in meteoritic classification, the most important functions being performed obviously by structure and mineral composition.

[3] *V., e.g.,* O. C. Farrington's *Meteorites,* Ch. 12, "Classification of Meteorites," 197-204, 1915.

[4] *V.* G. T. Prior, "The Classification of Meteorites," *Min. Mag.,* **19**, 51-63, 1920, and also the "Introduction" to his *Catalogue of Meteorites. . . . . Britsh Museum* (*Natural History*), vi-viii, 1923.

[5] Except only the 5 subclasses of octahedrites (O), whose names remain unchanged and whose symbols virtually so, in the simplified classification; but *v.* n. (‡) to Table 4.

[6] The part of the subclass name that may, for brevity, be omitted in speech, is inclosed in parentheses (*v.* Table 4); *e.g.,* (olivine-anorthite-)hypersthene sideraerolite (symbol = Shao); but the *symbol* for the subclass should never be curtailed.

[7] One writer has referred to them as "pallasiderites," but the designation "lithoöctahedrites" is manifestly more in keeping with the nomenclature of the simplified classification.

[8] *Cf.* Stuart H. Perry's "The Metallography of Meteoric Iron," *U. S. Nat. Mus. Bull. 184,* vii + 206 pp., 1944, both text and plates; in particular, pp. 5, 7, 47-8, 54, 64-5, and Fig. 8, p. 48. "The demarcation in classifying the different types of structure is not definite. Thus, there is a narrow 'twilight zone' between hexahedrites and octahedrites [amounting, in their compositional range, to about 1% nickel], and a wider one between octahedrites and [nickel-rich] ataxites," amounting to as much as 5% in that range (last par., p. 47).

[9] In the compound symbol for either a "composite" or a "transitional" meteorite, the symbol for the subclass of the more prevalent or conspicuous component should appear first and that of the less prevalent or conspicuous one second; if both components are equally prevalent or conspicuous, the symbols for their subclasses should appear in the order in which the subclasses occur in the classificational sequence (*post*).

[10] *C.M.S.,* **4**, 87-92; *P. A.,* **56**, 41-6, 1948.

[11] *C.M.S.,* **4**, 145-6; *P. A.,* **56**, 441-2, 1948.

The Total Known Weight of the Cape York, Greenland, Sideritic Fall (ECN = +0650,760:)*

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ABSTRACT

The total known weight of the Cape York, Greenland, sideritic fall, which includes 4 recovered individuals—"Ahnighito," the Savik iron, "the Woman," and "the Dog"—appears, in the light of the best available information, to be approximately 66 *metric* tons.

The Savik iron (weight = 3402 kg.) and the Furnas County member (weight = 1073 kg.) of the Norton County, Kansas-Furnas County, Nebraska, achondritic shower of 1948 February 18 raise to 68 the total number of known individual meteorites weighing 400 kg. or more.

The largest recovered member of the Canyon Diablo, Arizona, sideritic fall

*Read at the 14th Meeting of the Society, Los Angeles, California, 1951 June 18-19.

(weight = 639 kg.) has recently been placed on permanent display in the new museum building on the north rim of the Barringer Meteorite Crater.

The following excerpt is taken from Chester A. Reeds' "Catalogue of the Meteorites in the American Museum of Natural History as of October 1, 1935"[1]:

"*Cape York, West Greenland.* Found: 1894. Siderite: Medium octahedrite. Om. Specimens: [enumeration here omitted]. Remarks: Knives of iron with bone handles were given to Captain John Ross in 1818 by the Eskimos of Prince Regent's Bay. Three large masses, weighing respectively 36.5 tons, 3 tons, and 898 lb. [this third weight, as listed under 'Specimens,' = 896.5 lb.], and named 'The Tent' or Ahnighito, 'The Woman,' and 'The Dog,' respectively, were shown in 1894 to Lieut. R. E. Peary, by whom later they were transported to New York and placed in the American Museum of Natural History. A fourth mass of meteor[it]ic iron, weight 3401.7 kg., was found by the natives in 1913 on the Savik peninsula, 9 and 13 km. from the places where the other masses were found. The Savik mass was transported to Copenhagen in 1925. It is a medium octahedrite and has the same composition as the three masses in New York."

The Savik iron (weight = 3402 kg.) was inexplicably omitted from our "Catalog of the Largest-Known Meteorites of the World" and its supplement.[2] This specimen should, of course, have been included in that catalog, for it ranks among the 15 largest-known individual meteorites of the world and is the second weightiest member of the Cape York, Melville Bay, West Greenland, sideritic fall, "the Woman" and "the Dog" being respectively the third and fourth members of that fall in point of weight.

In a note entitled "The Weights of the Two Largest-Known Meteorites,"[3] it has been pointed out that the weight of "Ahnighito," the largest of the 4 recovered Cape York irons, is probably 65 or 66 tons of 2000 lb.; taking the mean of these 2 values, we shall assume that the most likely weight of this mass is 65½ short tons = 59,545 kg. The currently accepted weights, in kilograms, of the 4 recovered Cape York siderites are, then, as follows:

Ahnighito	59,545 kg.
Savik	3,402
The Woman	2,727
The Dog	407

Hence, the total weight of this remarkable fall appears to be 66,081 kg., or very close to 66 *metric* tons.

After the forenamed catalog and its supplement[2] were compiled, the now famous achondritic shower of Norton County, Kansas-Furnas County, Nebraska (ECN = + 1000,400) occurred (on 1948 February

18, at 4:56 P.M., C.S.T.). The great Furnas County member of that fall has been estimated to weigh at least 2360 lb.[4] = 1073 kg., and so this specimen ranks among the 30-odd largest-known meteorites of the world; it is, moreover, the only known aerolite, other than the Long Island, Kansas, stone (ECN = + 0996,399; subcl. = C(iv); weight = 565 kg.), that weighs in excess of 400 kg., and the only meteorite of *any* kind, weighing upward of that figure, that has been *observed* to fall. The Savik octahedrite and the Furnas County achondrite raise to a total of 68 the number of known individual meteorites that weigh 400 kg. or more.

In the supplementary paper on the largest-known meteorites of the world,[5] it was stated that the 639-kg. member of the Canyon Diablo, Arizona, sideritic fall (ECN = + 1110,350; subcl. = O(gg))—the largest recovered individual from that fall and the property of the Barringer family—"is on loan to the American Meteorite Museum, on U. S. Highway 66, near 'Crater Junction.'" It should now be recorded that the individual in question has since been transferred to and has been placed on permanent exhibition in the fine new museum building that is rapidly nearing completion on the north rim of the Barringer Meteorite Crater.

REFERENCES AND NOTE

[1] *Bull. Am. Mus. Nat. Hist.*, **73**, Art. 6, 546, 1937.

[2] *C.M.S.*, **4**, 71-5; *P. A.*, **55**, 497-502, 1947, and *C.M.S.*, **4**, 101-2; *P. A.*, **56**, 156-8, 1948.

[3] *C.M.S.*, **5**; *P. A.*, **59**, 33, Jan., 1951.

[4] Carl W. Beck & Lincoln LaPaz, "The Nortonite Fall and its Mineralogy," *Am. Mineralogist*, **36**, 45-59, 1951. "The weight of the principal mass is inferred to be at least 2360 lb., and the integrated weight of the recoveries so far made is estimated as in excess of 2500 lb." (Abstract, p. 45). This fall has been classified as an olivine-enstatite calcium-poor achondrite (A_2eo).

[5] *C.M.S.*, **4**, 101-2; *P. A.*, **56**, 156-8, 1948.

1951 May 18

Death of Dr. Curvin H. Gingrich

It is with sorrow and a feeling of keen personal loss that we record the sudden death, from a heart attack, on 1951 June 17, at the age of 70, of Dr. Curvin H. Gingrich, for many years Professor of Mathematics and Astronomy in Carleton College and Editor of POPULAR ASTRONOMY. At the time of his death, Dr. Gingrich was a Fellow, a Patron, and a Councilor of the Meteoritical Society and also a member of its Committee on Publications. He had been associated with the Society ever since its inception in 1933, when, thru him, arrangements had been consummated to publish its CONTRIBUTIONS in POPULAR ASTRONOMY. His sympathetic interest, active coöperation, and never-failing help during the past 18 years have been invaluable, and are

hereby acknowledged with the deepest gratitude. By his death the Society has been bereaved of a well-nigh indispensable member.*

FREDERICK C. LEONARD

*A more detailed obituary of Dr. Gingrich will be found elsewhere in this issue of POPULAR ASTRONOMY.

President of the Society: L. F. BRADY, Museum of Northern Arizona, Flagstaff, Arizona

Secretary of the Society: JOHN A. RUSSELL, Department of Astronomy, University of Southern California, Los Angeles 7, California

The Planets in September and October, 1951

By RAYMOND H. WILSON, JR.

NOTE: The time employed is Central Standard Time unless otherwise indicated. The phenomena have been chosen and described for the North American continent, and especially for the United States. The basic data have been taken principally from the *American Ephemeris and Nautical Almanac*.

Sun. The sun's southward shift in declination will be most rapid and noticeable, amounting to 23 degrees for the two-month interval. On September 23 at 3 P.M. it will cross the equator, and by the end of October it will have reached 14 degrees south of that line.

The second eclipse of the sun this year, at sunrise on September 1, will be visible as partial from the eastern half of the United States, and as about 95% annular from a small region along the Virginia-North Carolina border.

Moon. The phases of the moon will occur as follows:

New Moon	September	1	7 A.M.
First Quarter		8	12 M.
Full Moon		15	7 A.M.
Last Quarter		22	10 P.M.
New Moon		30	8 P.M.
First Quarter	October	7	6 P.M.
Full Moon		14	7 P.M.
Last Quarter		22	6 P.M.
New Moon		30	8 A.M.

The moon will be at perigee on September 11 and October 7.

An occultation of Regulus will be visible from all the United States except the southern border on October 25, shortly after 4:40 A.M.

Evening and Morning Stars. Jupiter will be visible nearly all night. The morning sky will display Mars, and later, in October, Venus and Saturn.

Mercury. The elusive planet will be at maximum distance of 18 degrees west of the sun on September 16, and might be seen at dawn, some 8 degrees north of Venus, for about a week around that date.

Venus. Inferior conjunction of Venus with the sun on September 3 will preclude its visibility during the first week of that month. However, it will appear to recede rapidly from the sun, so that it will reach the epoch of greatest brilliance in the morning sky by October 10.

Mars. Mars will be rising more than two hours ahead of the sun, although in position and magnitude it will not yet be very conspicuous. On October 3 it

will pass less than a degree north of Regulus; it will be fainter and redder than that star.

Jupiter. Since it comes to opposition with the sun on October 2, Jupiter will be a most conspicuous object all night during this period.

Saturn. Saturn's passing conjunction with the sun on September 29 will cause it to be invisible during most of this period, but by the end of October it might be picked up in the bright dawn.

Uranus. Uranus will be moving slowly eastward at about 2 degrees north of ζ Geminorum.

Neptune. Its conjunction with the sun on October 13 will make observation of Neptune impractical during most of this period.

Department of Mathematics, Temple University, Philadelphia, Pa.
June 30, 1951.

Asteroid Notes

By HUGH S. RICE

We are giving herewith the positions of the brightest minor planets visible during the latter part of the summer. They are all found in the same general region of the sky, the apparent paths lying between 22^h and 1^h R.A. and between $+15°$ and $-30°$ declination.

Asteroid 63 AUSONIA (magnitude 9.5) is at opposition August 29 and appears in central Aquarius. 10 HYGEIA (mag. 9.7) is at opposition September 6, and starts in Pisces, southwest of the "circlet" and moves into Aquarius. 101 HELENA (mag. 9.8) is at opposition September 7, and is in Aquarius, north of the lantern-figure, moving quite east-and-west. The famous asteroid 1 CERES is of magnitude 8.0 and thus within range of binoculars. The date of opposition is September 8, and its place is southern Aquarius, between the lantern-figure and Fomalhaut. Planet 471 PAPAGENA (mag. 8.8) is at opposition September 22, and may be found in northern Sculptor. Finally, 247 EUKRATE (mag. 9.7) is at opposition October 1 and appears first in Pisces; later it goes into Pegasus, passing about 2° south of Gamma Pegasi in mid-October.

Our ephemerides are taken from the official work published by the Cincinnati Observatory, except that the last two positions of CERES were obtained from the *Circulars* of the U. S. Naval Observatory, because the Big Four asteroids have their positions given in more detail there.

ASTEROID EPHEMERIDES

0^h U.T. Equinox 1950

1951	63 AUSONIA α h m	63 AUSONIA δ ° ′	1951	10 HYGEIA α h m	10 HYGEIA δ ° ′
Aug. 2	22 54.5	— 9 6	Aug. 12	23 13.7	— 0 15
12	22 47.3	— 9 22	22	23 7.7	— 0 40
22	22 38.1	— 9 43	Sept. 1	23 0.6	— 1 15
Sept. 1	22 28.1	—10 4	11	22 53.2	— 1 56
11	22 18.5	—10 22	21	22 46.2	— 2 38
21	22 10.6	—10 34	Oct. 1	22 40.3	— 3 17

101 Helena		
1951	α h m	δ ° ′
Aug. 12	23 26.0	— 6 18
22	23 18.6	— 6 7
Sept. 1	23 9.1	— 6 3
11	22 58.9	— 6 2
21	22 49.2	— 5 59
Oct. 1	22 41.2	— 5 50

1 Ceres		
1951	α h m	δ ° ′
Aug. 12	23 25.7	—19 57
22	23 19.4	—21 7
Sept. 1	23 11.6	—22 11
11	23 3.2	—23 3
21	22 55.0	—23 37
Oct. 1	22 48.0	—23 51
11	22 43.0	—23 45
21	22 39.8	—23 21

471 Papagena		
1951	α h m	δ ° ′
Sept. 1	0 12.6	—25 59
11	0 5.8	—27 21
21	23 57.6	—28 17
Oct. 1	23 49.2	—28 42
11	23 41.8	—28 32
21	23 36.5	—27 44

247 Eukrate		
1951	α h m	δ ° ′
Sept. 11	0 54.7	+ 8 36
21	0 43.3	+10 9
Oct. 1	0 29.6	+11 32
11	0 15.3	+12 45
21	0 2.0	+13 47
31	23 51.3	+14 39

Hayden Planetarium, American Museum of Natural History, New York, 1951 July 14.

Occultation Predictions for September and October, 1951

(Taken from the *American Ephemeris*)

Date 1951	Star	Mag.	Immersion: Greenwich C.T. h m	Immersion: a m	Immersion: b m	Immersion: Angle E from N °	Emersion: Greenwich C.T. h m	Emersion: a m	Emersion: b m	Emersion: Angle E from N °
Occultations Visible in Longitude +72° 30′, Latitude +42° 30′										
Sept. 17	δ Psc	4.6	1 33.8	—0.3	+2.0	43	2 37.3	—0.9	+1.7	247
Oct. 10	η Capr	4.9	0 2.1	..	..	357	0 37.0	..	..	304
12	λ Aqar	3.8	1 45.1	—0.6	+1.9	15	2 47.7	—2.2	—0.1	266
12	78 Aqar	6.3	3 10.3	—0.7	+1.5	20	4 14.3	—1.7	—0.5	260
17	ϵ Arie	4.6	1 39.5	—0.3	+1.8	62	2 45.3	—0.7	+1.9	241
20	406 B.Taur	5.6	7 25.3	—2.2	—0.3	110	8 50.3	—2.2	+1.2	247
25	α Leon	1.3	11 5.4	—1.5	—0.9	131	12 28.4	—1.7	—1.1	301
Occultations Visible in Longitude +91° 0′, Latitude +40° 0′										
Sept. 11	248 B.Sgtr	5.6	3 49.0	—2.9	—2.1	127	4 27.0	+0.3	+1.6	190
20	7 Taur	5.9	11 12.2	—1.8	+1.9	41	12 23.4	—1.5	—2.1	288
22	354 B.Taur	6.3	9 56.4	—2.6	—1.0	119	11 9.7	—2.1	+2.8	225
28	45 Leon	5.9	11 38.8	—0.6	—2.5	170	12 22.7	—1.4	+3.1	247
Oct. 8	τ Sgtr	3.4	0 14.1	—1.8	+0.4	62	1 32.2	—1.8	—0.5	266
17	ϵ Arie	4.6	1 35.7	+0.3	+1.9	44	2 30.8	—0.4	+1.5	263
20	406 B.Taur	5.6	6 49.9	—1.5	+0.9	99	8 9.6	—1.6	+1.9	246
25	α Leon	1.3	10 46.8	—1.0	—1.9	159	11 50.3	—2.2	+1.4	264
26	56 Leon	6.0	11 41.4	—1.2	0.0	120	12 58.7	—1.4	—0.9	312
Occultations Visible in Longitude +98° 0′, Latitude +31° 0′										
Sept. 20	7 Taur	5.9	10 45.5	—2.5	+0.9	68	12 19.5	—2.2	0.0	253
24	47 Gemi	5.6	11 2.0	—1.7	+2.8	58	12 15.4	—2.5	—2.4	317
Oct. 7	τ Sgtr	3.4	23 54.6	—2.3	+0.7	72	1 20.8	—2.2	0.0	258
9	η Capr	4.9	23 2.5	..	..	359	23 30.7	..	..	317
12	λ Aqar	3.8	1 7.3	..	..	344	1 32.3	..	..	305
12	78 Aqar	6.3	2 36.6	..	..	342	3 7.3	..	..	297
19	38 B.Auri	6.5	12 28.1	—1.3	—2.4	120	13 40.7	—1.4	—0.3	249
20	406 B.Taur	5.6	6 34.7	—1.7	—0.1	117	7 37.3	—0.7	+3.3	221
26	56 Leon	6.0	11 42.9	—0.8	—2.1	160	12 47.1	—2.3	+0.9	272

Date 1951	Star	Mag.	IMMERSION Greenwich C.T.	*a*	*b*	Angle E from N	EMERSION Greenwich C.T.	*a*	*b*	Angle E from N
			h m	m	m	°	h m	m	m	°
OCCULTATIONS VISIBLE IN LONGITUDE +120° 0′, LATITUDE +36° 0′										
Sept. 7	CD—23°12133	6.4	1 26.7	—2.1	—0.8	99	2 46.6	—1.7	—1.5	300
11	248 B.Sgtr	5.6	2 41.2	—2.0	+0.4	100	3 55.8	—1.8	+0.9	229
14	σ Aqar	4.9	7 36.3	—3.1	—0.9	102	8 22.6	+0.3	+2.7	178
20	7 Taur	5.9	10 19.9	—0.4	+3.9	16	11 20.6	—3.2	—1.3	291
22	354 B.Taur	6.3	9 3.1	—0.8	+1.3	88	10 16.2	—1.0	+2.1	242
28	ρ Leon	3.8	14 5.3	—0.9	—0.7	139	15 16.9	—1.6	+0.4	284
Oct. 11	ι Aqar	4.4	3 0.9	..	..	128	3 25.3	..	..	163
19	38 B.Auri	6.5	11 32.5	—2.6	—1.4	112	12 57.7	—2.4	+0.8	241
20	406 B.Taur	5.6	6 25.8	+0.1	+1.7	68	7 29.8	—0.7	+1.2	271
25	α Leon	1.3	10 38.1	..	..	192	10 51.7	..	..	215

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By MARGARET W. MAYALL, Recorder

Light Curve of R Scuti. The accompanying curve is plotted from observations collected by Mr. Campbell. The early 19th century observations were made by Argelander, Schmidt, Oudemans, Schoenfeld, Auwers, Winnecke, Chandler, Schwab, Sawyer, and others. From 1911 to 1951, the plot is from the mean light curve of AAVSO observations.

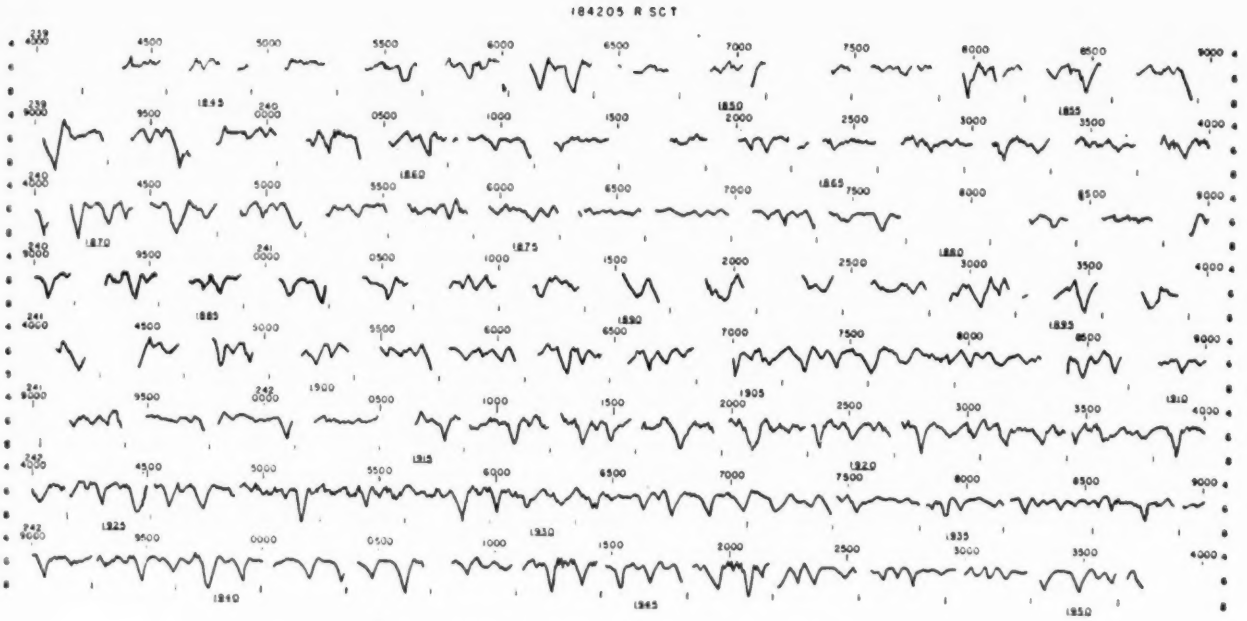
Variable Star Catalogue. The Second Supplement of the General Catalogue of Variable Stars by Kukarkin and Parenago has been issued. The General Catalogue (published 1948) listed 10,912 named variable stars, and the First Supplement (1949) contained 265 additional ones. This Second Supplement (1950) lists 850 more, making a total of 12,027 variables which have been assigned names.

Miscellaneous Notes on the Variables.

0016*20* T Cet. An interesting, bright, semi-regular variable, with a range from about 5.5 to 7.0 magnitude. An excellent object for city observers, or any who use binoculars. It is marked on the edge of the type "a" chart for 2357*15* W Ceti, but a new chart is in process.

024217 T Ari. A very broad, flat maximum, lasting about 100 days, occurred between December, 1950, and March, 1951.

042209 R Tau. A bright maximum, 8th magnitude, the first of February.



LIGHT CURVE OF 184205 R SCUTI, FROM 1842 TO 1951

More than 100 years of observations collected and plotted by Leon Campbell.

043065 T Cam. An 8th magnitude maximum occurred in the middle of April. The usual still stand was not observed during the rise to maximum.

053337 RU Aur. A 10th magnitude maximum was observed the last of February. It was a magnitude fainter than the previous one.

0547*05* CN Ori. This Z Camelopardalis type star is a good object for the observer who can reach 14 or 14.5 magnitude. It has an approximate period of 19 days.

060547 SS Aur. A maximum was observed on J.D. 2,433,752, an interval of 40 days from the preceding maximum.

061115 CZ Ori. This SS Cygni type star was brighter than 12 on J.D. 2,433,782, more than 50 days after the preceding maximum.

0652*08* X Mon. A good object for the observer with a small telescope. It has a period of 155 days, and a mean range in magnitude from 7.6 to 9.0. At times it varies from about 7.0 to 10.0 magnitude.

0742*41* W Pup. A bright maximum, nearly 8th magnitude, the last of April, followed the 9th magnitude one in January.

074922 U Gem. A very narrow maximum, 10.5 magnitude, was observed on J.D. 2,433,761, after an interval of 66 days.

0756*12* U Pup. A very bright maximum, nearly 8th magnitude, was observed in the middle of May.

1032*70* RZ Car. A 9th magnitude maximum was observed the first of December, following one of 10.5 magnitude.

155947 X Her. Another good variable for the observer with binoculars. It is quite irregular, and varies from about 5.8 to 7.4 magnitude. A chart for it will soon be ready for distribution.

1724*86* S Oct. An 8th magnitude maximum was observed the last of March, the second bright maximum since the 10th magnitude one in November 1949.

195849 Z Cyg. A faint maximum, 9.5 magnitude, was observed the middle of June, following an 8th magnitude one the last of September, 1950.

2035*01* AE Aqr. A variable that should be given very close attention. It is probably an SS Cygni type star, with flares lasting about an hour, and possibly recurring about once a day.

2049*54* S Ind. An 8th magnitude maximum in the middle of April follows one at 10.5 in February, 1950.

213843 SS Cyg. A maximum at 8.4 magnitude was observed in the middle of June. The star showed great irregularity between this maximum and the previous one in early May.

220912 RU Peg. A poorly observed maximum in early May.

224552 DK Lac. Nova Lacertae 1950 has decreased to a little fainter than 12th magnitude by the last of June.

Observations received during May and June, 1951. A total of 7,427 observations was received during these two months. In May, 72 observers contributed 3,857 observations, and in June, 3,570 observations were received from 58 observers.

	May—1951—June					May—1951—June			
Observer	No. Var.	No. Ests.	No. Var.	No. Ests.	Observer	No. Var.	No. Ests.	No. Var.	No. Ests.
Adams, R. M.	56	132	55	136	Bereси, Zsolt	6	15	..	..
Ahnert, P.	25	214	28	169	Bicknell, R. H.	7	25	10	31
Ancarani, M.	20	32	22	25	Blunck, V. H.	12	16	12	18
Armfield, L. E.	..	..	4	4	Bogard, David	42	48	56	81
Bartha, L.	7	29	..	..	Born, E.	31	282	..	..

Observer	May—1951—June No. Var.	No. Ests.	No. Var.	No. Ests.
Boutell, H. G.	5	22	6	19
Buckstaff, R. N.	14	36	18	48
Cain, C. V.	2	4	1	3
Charles, D. F.	8	10	25	40
Cisler, Ed	..	..	2	2
Cobb, Hensley	3	4	..	..
Cooke, S. R. B.	4	4	38	89
Costello, R. B.	20	20	6	6
Cragg, T. A.	..	..	1	1
Dafter, Rosina	7	16	..	..
Darling, Birt	12	15	..	..
Darnell, P. B.	1	9	1	10
Darsenius, G. O.	9	26	16	34
Diedrich, DeL.	1	1	2	4
Diedrich, G.	2	4	5	19
Domke, K.	30	191	..	..
Estremadoyro, V. A.	10	19	9	9
Fernald, C. F.	138	200	127	199
Fernald, E. S.	3	3	2	3
Ficonetti, Rene	14	30	18	29
Ford, C. B.	..	..	31	41
Galbraith, W.	20	20	40	142
Goodsell, J. G.	2	2	..	..
Greenley, R. M.	66	158	73	151
Hack, Frigyes	2	3	..	..
Halvorson, D.	12	16	12	29
Hartmann, F.	130	133	134	146
Henderson, R.	6	9	..	..
Hiett, Lancaster	19	37	14	18
Jáger, Tamás	6	18	..	..
Jahn, Artur	5	23	..	..
Jerabek, H. S.	5	15	5	17
Kato, H.	23	48	..	..
Kelly, F. J.	12	12	11	11
Kirchhoff, Peter	..	..	25	59
Knowles, Jeremy	17	19	15	16

Observer	May—1951—June No. Var.	No. Ests.	No. Var.	No. Ests.
de Kock, R. P.	115	324	134	442
Lacchini, G. B.	16	32	..	..
Leutenegger, E.	..	..	35	96
LeVaux, H. A.	20	20	40	40
Lovas, Miklos	4	8	..	..
Meek, J. W.	40	190	..	..
Melville, E. C.	9	15	8	11
Miller, W. A.	13	22	15	21
Montague, A. C.	10	16	18	28
Morrisby, A. G.	13	34	14	34
Motley, Gary	18	28	32	59
Oravec, E. G.	72	193	54	105
O'Sullivan, W.	11	26	15	39
Parker, P. O.	28	28	27	27
Pearcy, R. E.	..	..	10	10
Peltier, L. C.	55	209	45	136
Penhallow, W.	1	1	..	..
Peter, Hermann	..	..	35	365
Pohl, Eckhard	21	111	..	..
Renner, C. J.	95	95	183	183
Rick, Louis	2	2	1	2
Rosebrugh, D.	19	114	28	105
Schulte, Dan	7	7	11	11
Segers, C. L.	14	50	12	22
Sinka, Jozsef	4	9	..	..
Snow, Dan	6	6	..	..
Sofronijewitsch, D.	24	140	..	..
Taboada, D.	38	38	18	18
Tarwater, C.	42	116	46	103
Török, Ervin	6	24	..	..
Tury, Kornél	4	11	..	..
Venter, S. C.	30	41	28	48
Weber, J. A.	20	20	30	30
Welker, Frank	..	..	16	16
Whitehill, S. L.	7	7	7	10

Nova Search. Nova Search reports were received during May and June from 16 observers, as follows:

Observer	MAY Area	No. Nights	Mag.	JUNE Area	No. Nights	Mag
Adams, R. M.	53, 54	3	8	53, 54	4	8
	65, 66	6	8	57, 58	1	8
	71, 72	4	8	71, 72	5	8
	71, 72	2	6	71, 72	1	7
				172, 173	3	8
Blunck, V. H.	8, 9, 10	4	6	8, 9, 10	2	6
**DeKinder, F.	36	5	8	59	6	8
	59	3	8			
*Diedrich, DeL.	40, 94	1	3	40	1	6
*Diedrich, G.	Dome	1	2	Dome	3	2
	Dome	1	1	Dome	2	1
	56	1	6	56	2	5
	56	1	4	56, 78	2	4
				56	2	3
**Dufresne, R.				39	3	6
**MacLennon, A. K.				23	4	6

	MAY			JUNE		
Observer	Area	No. Nights	Mag.	Area	No. Nights	Mag.
**Milton, E.	10	4	6	46	5	6
**Morgan, F.	34	2	6			
**Noseworthy, T.	82	8	6	26	5	6
				82	6	6
*Rick, Louis	Dome	5	1			
	18	1	3	Dome	1	2
				Dome	8	1
				18	2	3
Rosebrugh, D. W.	Dome	6	3	Dome	5	3
	1, 34	2	4	Dome	1	2
				1	3	4
				34	1	4
Smith, F. W.	3, 4	4	6	3, 4	2	6
**Williamson, I. K.	38	5	6	38	4	6
	79	2	6			
**Wright, Mrs. G.				40	2	6
**Zackon, B.	58	1	6	58	6	6
**Zorgo, Mrs. K.				41	11	6

*Members of the Black River Astronomical Society.

**Members of the Montreal Center of the Royal Astronomical Society of Canada.

July 13, 1951.

Comet Notes

By G. VAN BIESBROECK

No new comets have been announced in the course of the two last months. Of those that were mentioned earlier this year, none is any longer in reach of telescopes of moderate size. The least faint of these is PERIODIC COMET 1951 *f* which has been well observed since its discovery by L. Kresák on April 24. When last seen here on July 5, it appeared as a large diffuse coma, some 4′ in diameter with a poorly defined central nucleus. The total brightness corresponded to a star of 13th magnitude, but the nucleus was not brighter than 15 mag. From now on that object is expected to fade rapidly, but, moving from the constellation of Boötes into that of Serpens, it is still favorably located for northern observers.

Both the discoverer L. Kresák and L. E. Cunningham at Berkeley have noticed the analogy of the elements with those of PERIODIC COMETS 1858 III (TUTLE) and 1907 III (GIACOBINI). In 1858, the comet was followed for a month only and in 1907 the observations cover only 10 days. The period deduced from these short apparitions is necessarily quite uncertain. Since the orbit passes near that of Jupiter, large planetary perturbations have probably taken place. The present more favorable apparition will make it possible to obtain a better orbit which might serve as a basis for backward computations in order to connect the various apparitions.

Exceptionally bad weather has prevented observations here of the faint PERIODIC COMETS PONS-WINNECKE, KOPFF, and NEUJMIN. The two first ones will soon be too far in the western sky. Only PERIODIC COMET TEMPEL was recorded July 5 and 6 as a little round coma of about 17th magnitude which is almost two magnitudes fainter than the ephemeris value. On July 7 no trace of

PERIODIC COMET ENCKE could be found on plates showing 17th-magnitude stars. Unless southern observers have better luck, this object will soon be out of sight.

This fall the return of two more periodic comets is expected, namely, SCHAUMASSE (period 8.17 years) and GRIGG-SKJELLERUP (period 4.90 years). The first which was observed in 1944 does not come to perihelion until 1952, February 9, and should be an easy object toward the end of this year. The second will remain much fainter.

Williams Bay, Wisconsin, July 11, 1951.

General Notes

Dr. Charles Dillon Perrine died after a short illness at the advanced age of 83 years on the 21st of June, 1951, in his residence at Villa General Mitre, Argentina, a little town about 80 km. away from Córdoba. He began his fruitful career in 1893 at the Lick Observatory, Mount Hamilton, California, where he carried on several tasks, one of them as an astronomer, making himself known by his discoveries, observations and orbits of comets as well as by his observations for the determination of the solar parallax by means of the asteroid Eros, and the discovery of the 6th and 7th satellites of Jupiter. In 1897 he was awarded the Lalande prize of the Academy of Paris, and in 1902 he was President of the Astronomical Society of the Pacific.

He retired from Lick Observatory in 1909 in order to accept an appointment as director of the Córdoba Astronomical Observatory, Argentina, holding this position for more than a quarter of a century, until pensioned in 1936. His intense and manifold labor at the head of this institution has found its highest expression in the the creation of the Astrophysical Station at Bosque Alegre with its reflector of 60 inches. Sixteen volumes of the *Resultados del Observatorio Nacional Argentino* were published during his directorship.

(This article was furnished by Primer Astrónomo Jorge Bobone, Observatorio Astronómico de Córdoba, Córdoba, Argentina.)

Dr. Frederick C. Leonard, Professor of Astronomy in the University of California, Los Angeles, and Editor of the Meteoritical Society, gave a lecture on meteorites, illustrated with slides and specimens, on July 13, 1951, before the Institute for Teachers of Mathematics, held at the University of California, Los Angeles, July 9-20, 1951.

The Cleveland Astronomical Society

The Cleveland Astronomical Society held its final meeting of the season Friday night, May 25th. This meeting was preceded by the annual dinner. Dr. J. J. Nassau, President of the Society, was the speaker and his subject was, "Our Place in the Universe."

Dr. Nassau suggested that the audience go with him, in their imagination, to the airport on a clear winter evening and take a flight in an airplane. At first they would find themselves in the midst of a large number of lights of varying size and brightness. As the plane gained altitude the lights would become dimmer and gradually merge into a common haze except the very brightest ones. New patches of haze would begin to appear on the horizon in various directions (indicating other cities) and as the plane neared them individual lights would begin to appear.

In the same way we are in the midst of our galaxy and see individual stars

but when looking out to other groups of stars like our own they appear as hazy patches except when the largest telescopes are used.

The speaker took inventory of the great variety of objects that occur in our galaxy, most of which have been found in other galaxies as well. We are still quite ignorant of what lies between the galaxies, he said, but reddening of these objects with distance may mean interstellar material and a few stray stars might be present but too few to include in the inventory.

Dr. Nassau then proceeded to explain what the astronomers at the Warner and Swasey Observatory are doing to try to work out the structure of the Milky Way in our own galaxy. He had drawn a cross-section in the plane of the Milky Way showing the relative position of the important features in that part of the Milky Way visible from this latitude. Extending nearly the full length of the Warner Memorial Auditorium was a chart of this region made on the same scale as the 8-inch circular plates obtained with the 24-inch Schmidt-type telescope. Among other things some 930 highly luminous stars had been plotted on this chart which covered 180 plates. Several hundred plates were required, however, to obtain all the information plotted.

Step by step the audience were taken around the Milky Way and points of interest noted on slides, the large chart on the wall and the drawing on the blackboard.

It was a very interesting evening ending with a visit to the dome to see the new photoelectric photometer mounted on the Burrell 24-inch Schmidt-type telescope and to see Saturn through the smaller refractor.

HENRY F. DONNER, *Recording Secretary.*
Western Reserve University, Cleveland 6, Ohio.

Provisional Sunspot Numbers for May, 1951*

1	62	11	102	21	180
2	56	12	125	22	154
3	78	13	155	23	140
4	51	14	170	24	117
5	46	15	184	25	114
6	20	16	212	26	93
7	26	17	220	27	87
8	17	18	229	28	81
9	32	19	204	29	51
10	34	20	180	30	48
				31	46

Mean Value for May
R = 108.5

Provisional Sunspot Numbers for June, 1951*

1	38	11	133	21	134
2	38	12	147	22	123
3	37	13	159	23	93
4	26	14	163	24	63
5	65	15	158	25	60
6	103	16	147	26	63
7	115	17	152	27	48
8	130	18	157	28	45
9	138	19	146	29	43
10	137	20	138	30	18

Mean Value for June
R = 100.6

*From the Zürich Observatory, furnished by Mr. Neal J. Heines.

The Conjunction of Venus with the Sun, September 3, is especially interesting in that it provides an exceptionally large geocentric latitude of Venus. A large geocentric latitude occurs near conjunction when the heliocentric latitude is large, that is, when the conjunction occurs with Venus having a heliocentric longitude 90° greater or less than that of the node of the orbit of Venus, namely, with a longitude of 166° or 346°. Venus is at the latter September 7. At the conjunction the geocentric latitude is —8° 37′; on September 5 it is slightly larger —8° 39′.

As the orbit of Venus is very nearly circular, a March conjunction gives a slightly larger geocentric latitude since March 7 is slightly closer to January 1, the approximate time of the Earth's perihelion. A theoretical maximum value of the geocentric latitude can be obtained by supposing the Earth at perihelion and Venus at aphelion and also at its greatest heliocentric latitude. The resulting latitude would be 9° 33′; but these conditions do not, and cannot, exist simultaneously. The greatest actual value known to me occurred on March 4, 1846, when the geocentric latitude of Venus was +8° 49′. I should be glad to hear of any larger value.

Since the zodiac is the band of the sky which includes all the planets (except Pluto at times), naturally this latitude for Venus, which departs farthest from the ecliptic, determines the boundary of the zodiac. The limit should not be given as 8°, as is done by some. A 9° limit is quite acceptable.

SAMUEL G. BARTON.
33 N. Sixty-first Street, Philadelphia 39, Pennsylvania, July 28, 1951.

World-Wide Observations of Solar Activity. As part of a broad program for the coördination and centralization of information on radio propagation, the National Bureau of Standards makes advance forecasts of poor or unusual conditions for short-wave radio reception. This service, performed by the NBS Central Radio Propagation Laboratory, is based in large part on the association of solar activity with unusual conditions in the ionosphere, the series of ionized layers in the upper atmosphere.

High-frequency radio waves—propagated over long distances by alternate reflections at the ground and in the ionosphere—are directly affected by ionospheric disturbances. NBS therefore carries on an intensive study of ionospheric conditions and related astronomical and geophysical phenomena. Material assistance is rendered this program through the coöperative efforts of solar astronomers scattered throughout the world, who transmit information to NBS on the development and progress of sunspots, solar eruptions, and other activity on the sun.

Because sunspots are rather easily observed, many terrestrial disturbances are popularly attributed to their presence. However, the sunspot is but one type of solar activity and actually represents a relatively cool area on the sun's surface. Spectroscopic observations show concentrations of extremely hot gases in the sun's atmosphere at places where there may be no spot at all or only a very small spot. These observations also locate regions where the speed of the sun's gases is unusually high or where there is an extraordinarily intense local magnetic field.

While ionospheric disturbances, northern lights, magnetic storms, or bad radio reception cannot be attributed directly to sunspots, there is a close correlation between solar activity and these unusual terrestial effects. The world-wide accumulation of information about the active regions on the sun—which may or may not contain a sunspot—greatly aids the NBS "radio weather" forecasters

in anticipating interruptions to long-distance, short-wave radio communications.

The NBS forecasters must solve the problem of judging the degree of activity of the five or ten or fifteen centers of activity which may exist on the sun at any one time. From results of past experience and research in the last 70 years, it is known that there is a tendency for the most active of these regions to be associated with radio propagation disturbances, usually when the region is nearest the center of the sun's disk. Since the sun rotates quite slowly—once in about 27 days—the forecasters ordinarily have several days to gauge the activity of a region after it appears at the edge of the sun's disk, and then another few days in which to distribute their warning of the expected radio disturbance.

For accurate forecasts, the sun must be kept under constant observation; this means that cloudy weather must not be allowed to interfere with all observations simultaneously. While solar observatories are relatively few in number, they are specialized and are scattered throughout the world. Some are located on mountain peaks to take advantage of the thinner atmosphere and clearer skies; others are situated near universities interested in solar physics, but usually away from dust-filled city atmospheres. This dispersal permits the sun to be continually under observation, for while clouds may obscure the sun over one observatory, the sky is usually clear over another.

Sunspot measurements are regularly reported to NBS from two observatories in the United States and another two in Europe. The U. S. Naval Observatory, only a mile from NBS, reports its measurements by telephone as soon as they are completed. Mt. Wilson Observatory has the advantage of the normally clear California weather. In Germany, the Wendelstein Observatory makes sunspot observations many hours before the sun rises in the United States; as a result of the coöperation of the U. S. Army Signal Corps, these sunspot reports are often the first to arrive in Washington. Sunspot observations made at Meudon, near Paris, come later in the day by radio broadcast. Cloudy skies are seldom experienced by all four of these observatories on the same day; thus, detailed information on sunspot activity is available to the forecasters almost every day. Ordinarily a single patrol observation each day provides sufficient data.

The more specialized observations of solar activity usually require better observing conditions than those needed for sunspot measurements. An example is finding the location and brightness of concentrated clouds of calcium gas in the sun's atmosphere, which is done at the McMath-Hulbert Observatory, near Pontiac, Michigan, and then telegraphed directly to NBS. Mt. Wilson Observatory makes similar observations and, in addition, determines the polarity and intensity of sunspot magnetic fields from spectroscopic measurements.

Another important type of solar activity is the intense radiation from the sun's inner corona—the inner part of the sun's outer atmosphere. The corona is the most difficult of all solar phenomena to observe, making it necessary to locate observatories at high altitudes, where the sky is exceptionally free from dust and water vapor. Even though five widely separated observatories make such observations, there are frequently periods of several days during which reports of the emission regions of the corona cannot be obtained. Two of the coronal observatories are in the United States: one at Climax, Colorado, the other on Sacramento Peak, near Alamagordo, New Mexico. Climax is at an altitude of 11,500 feet while the Sacramento Peak Observatory is 9,200 feet above sea level. Although these observatories are only 450 miles apart, they are in different meteorological areas. Coronal observations from Europe are also sent promptly to the CRPL Warning Service. The Wendelstein Observatory, on a pinnacle south

of Munich, is a major contributor; another observatory, located on an isolated mountain top in the Pyrenees, sends its observations to Paris, where they are broadcast to the Western Hemisphere.

French, German, and Japanese scientists engaged in radio forecasting have their own organizations for collecting and distributing solar data. As an example, the French radio regularly broadcasts its compiled information which includes, besides solar activity observations, data on the terrestrial phenomena sometimes associated with solar activity. The Bureau obtains information from these broadcasts as well as from similar broadcasts originating in Germany and Japan.

The new science of radio astronomy also plays a role in the evaluation of solar activity. Unfortunately, most radio telescopes cannot resolve a center of activity on the sun. Nevertheless, the variations in the amount of radio-frequency energy emitted by the sun as a whole are useful in evaluating its total activity. Once a day or oftener, Cornell University sends a telegram to NBS giving measurements of 200-megacycle radiation from the sun; similar measurements at other frequencies are reported by telephone from a National Bureau of Standards field station near Washington. Observations at still another frequency are included in the daily message from Paris.

In all, seven solar observatories in the United States make both regular and special telephonic or telegraphic reports of unusual developments on the face of the sun to the NBS Radio Warning Service. Reports from an additional five solar observing stations in Europe arrive regularly at NBS by telegraph or radio every day. Observations of unusual phenomena are also received from time to time from these as well as the other major solar observatories of the world which do not report regularly. The NBS forecaster is thus one of the best informed persons on this planet regarding the goings-on detected on our sun. A few of the world-wide observations are made specifically for the use of the National Bureau of Standards, but a large proportion of the data from the far-flung network of observatories is available to the Bureau as one of the many laboratories studying solar activity and its effects. NBS, in turn, makes available to interested users summaries of the data or information it receives, and warns scientific laboratories as well as communications agencies of the presence and possible effect of solar activity.

(Technical Report No. 1536 from the National Bureau of Standards, Washington, D. C.)

New Novae Program. Three exploding stars were found in the Milky Way last year with a new nova-hunting technique, it was reported today by Drs. E. R. Herzog, Research Fellow in Astronomy, and Fritz Zwicky, Professor of Astrophysics, at the California Institute of Technology.

They recounted their findings in a report to the Publications of the Astronomical Society of the Pacific on the Palomar search for novae. The search is being pursued by the 18-inch Schmidt-type telescope, junior partner of the 200-inch Hale and 48-inch Schmidt-type telescopes at Palomar Observatory.

The 18-inch has been hunting novae along various lines of attack since it was installed in 1936. Beyond the Milky Way it has found 18 supernovae, or exploding giants which may reach 250 million times the brightness of the sun. In the Milky Way itself the 18-inch has spotted several common novae, which may reach the brightness of 60,000 suns.

A determined hunt for ordinary Milky Way novae was undertaken in the winter of 1949 because only about one hundred have been found during the past

two centuries. "Since all these discoveries were more or less incidental," the Mt. Wilson and Palomar Observatories astronomers explained, "we suspect that our knowledge of the possible types and characteristics of these objects, of the frequency of their occurrence, and of their distribution in space, is far from complete."

A general search in the winter part of the Milky Way was fruitless, they reported. So they adopted a restricted plan suggested by Dr. Albert G. Wilson, Senior Research Fellow in Astronomy.

They picked out 16 areas, covering regions in the constellations of Scorpius, Sagittarius, Aquila, and Cygnus, where novae have been found most often. They made spectral photographs of eight areas every night and the rest every other night for three weeks of every month between July and October.

In examining the photographs they put a new film slightly off center over an old one from the same area and studied the pair with low-power binoculars. Exploding stars showed up as images where no corresponding image was visible on the old film.

This method offered an excellent technique for finding novae, they concluded. They found three. And strangely, enough, all three were in the constellation Scorpius, and in the same general area of that constellation. For this the astronomers have no explanation. (The same three novae also were found independently by astronomers of the Astrophysical Observatory of Mexico at Tonanzintla.)

The first nova was found on July 20, 1950. It flared up to at least 10,000 times its normal brightness in four or five days, then began dimming. About three weeks later its luminosity started leveling off.

The second was discovered August 7. It was at least 10,000 times brighter than normal. For two weeks it declined slowly, then within the next month dropped rapidly.

The third nova was found September 3, by which time it was at least 6,000 times brighter than usual. Observations on this sample of "a star blowing its cover off" were too few to allow the astronomers to draw any conclusions. One hindrance to their work was heavy smoke from a forest fire which cast a pall over the mountain-top Observatory.

(A news release from the California Institute of Technology, June 10, 1951.)

Astronomical Illustrations. Yerkes Observatory at Williams Bay, Wisconsin, is now offering a new selection of one hundred 3¼ x 4-inch slides for the use of teachers and lecturers. Twenty-one entirely new photographs from the Yerkes collection are included in this set. A set of one hundred descriptive cards —a card corresponding to each slide—is available also, in revised form.

For fifty years the Yerkes Observatory has maintained a growing collection of astronomical photographs available for purchase by the public. Most of the more than 2,000 photographs have been taken by such past and present members of the Yerkes staff as Barnard, Ritchey, Ross, Struve, Hale, Hubble, Kuiper, Van Biesbroeck, Morgan, and Page. They have been taken with instruments at the Yerkes Observatory in Wisconsin, at the Mount Wilson Observatory in California, and at the McDonald Observatory in Texas.

During the past year the collection has been revised and re-catalogued by Dr. Thornton Page. Many new photographs have been added, some of them from Harvard's southern station at Bloemfontein, South Africa, from the Lowell Observatory in Arizona, from the High Altitude Observatory in Colorado, and

from other sources through the *Astrophysical Journal*, published by the University of Chicago Press. A new illustrated catalogue lists and describes the collection.

For many years a set of one hundred slides, with corresponding descriptive cards, selected from the total collection of photographs has proved invaluable to teachers and lecturers. The present revision of this slide set includes, in addition to the earlier, classic photographs of astronomy, a series of photographs of the largest prominence yet photographed at the High Altitude Observatory (1946); the far ultraviolet solar spectrum obtained from a V-2 rocket 85 miles above the earth (1947); filtered and composite photographs of the planets taken by Barnard, Ross, and Kuiper, the photographs on which new satellites of Uranus and Neptune were discovered by Kuiper (1948-49); photographs of the Magellanic Clouds from the Southern Hemisphere; photographs of many famous nebulae and clusters; the latest scheme of accurate spectral classification (Morgan, 1950); and photographs of large refracting and reflecting telescopes. New diagrams of the solar system, of the Galaxy, and of the Russell-Hertzsprung plot of stellar luminosities and spectral types are also included. The descriptive cards (200 to 250 words each) have been rewritten to give the latest accurate data and a suitable background for appreciation of the slides.

At a greatly reduced cost, sixty of these slides are now offered in the 2 x 2-inch size, and on 35-mm. film strip. Prints and transparencies are also available.

Besides this set of selected slides for general use, the new illustrated catalogue lists and describes slides and photographs illustrating specific research problems of modern astronomy and astrophysics: problems of the solar chromosphere and corona, of planetary atmospheres, of the origin of the solar system, of the aurora borealis, of lunar craters, of meteor and comet spectra, of interstellar clouds, of novae and supernovae, of the spectra of all types of nebulae, and of galactic structure. Maps of the neon and iron spectrum, views of modern and historical astronomical instruments, and portraits of ninety famous astronomers finish off the list. Copies of the illustrated catalogue may be obtained from the Yerkes Observatory, Williams Bay, Wisconsin.

(News release from the University of Chicago Press.)

Harvard's Southern Station. Harvard University's most distant outpost, the astronomical observatory in South Africa, is now being aided by a distinguished group of six South African citizens and three Americans working in South Africa.

The Boyden Station of the Harvard College Observatory is near Bloemfontein, South Africa. The nine-man advisory committee—The Friends of the Boyden Station—was recently formed to assist in the operation of the observatory.

Professor Bart J. Bok, Acting Superintendent of the Boyden Station, reports from South Africa that the committee is composed of the following men:

Dr. Colin F. Steyn, of Bloemfontein, Member of Parliament.

Dr. M. H. de Kock, Governor of the Reserve Bank, Pretoria.

Mr. Chester R. Chartrand, Public Affairs Officer of the American Embassy, Pretoria.

Mr. Albert Y. Gowen, of Johannesburg, prominent American industrialist.

Professor G. G. Cillie, Jr., of the University of Stellenbosch.

Mr. Wally Waugh, of Port Elizabeth, Managing Director of Firestone, South Africa.

Mr. Rene de Villiers, of Bloemfontein, Editor of "The Friend."

Mr. J. W. du Plessis, of Bloemfontein, member of the National Housing Commission.

Mr. W. A. Usher, City Engineer of Bloemfontein and designer of the buildings at the Boyden Station.

The Boyden Station was established in Peru in 1890 and was transferred in 1927 to the Orange Free State by Dr. Harlow Shapley, Director of the Harvard Observatory, assisted by the late Dr. John S. Paraskevopoulos. It has since become one of the leading observatories of the Southern Hemisphere.

Working in the clear skies of South Africa, the major project of the station today is the mapping of unexplored regions of the Milky Way. Thousands of photographs are being taken of the stars and interstellar dust which, with our own sun, make up the Milky Way.

The Boyden Station has been financed primarily by the funds of the Harvard College Observatory. Recently, however, an effort has been made to interest South Africans in lending support to the work of the station. The new committee will give advice on sources of support.

Dr. Bok says the committee will also serve to "promote cultural and scientific links between the United States and the Union of South Africa through their mutual interest in research findings at Boyden Station."

(News release from Harvard University, June 10, 1951.)

Book Reviews

The Computation of Elements of Eclipsing Binary Systems, by Zdenek Kopal. Harvard Observatory Monograph No. 8. (Harvard College Observatory, Cambridge 38, Massachusetts. 1951. Large Octavo, 182 pp. Heavy paper cover, $4.00; cloth binding, $5.00.)

In this monograph, Dr. Kopal assembles the methods of attack on this problem which have been developed by himself and by his collaborators. After an introduction and a discussion of the treatment of observational data, successive chapters deal with the computation of the intermediary elements, differential corrections, orbital eccentricity, and distorted eclipsing systems. Two appendices contain a discussion of least squares methods and a survey of the computational methods discussed earlier. As implied by the title, the chief concern is with methods of computation of elements; specifically, the methods are those based on the theoretical treatment presented in an earlier monograph. It will undoubtedly be useful to have easily at hand the means of applying these methods of attack to those cases in which they may prove appropriate.

By far the weakest parts of the book are those sections dealing with the treatment of observational data. While some of the ideas are thoroughly sound—such as the importance of publishing the individual observations — others are definitely misleading. Photoelectric observers will be surprised to learn that the accuracy of their measures is independent of the star's brightness. The discussion of the weighing of visual and photographic observations applies only to estimates, and ignores the many series of excellent visual and photographic measures. Further, it is highly doubtful whether the many refinements required by these methods should be applied to estimates since, as is pointed out in the introduction, any systematic error in the photometric scale vitiates the whole analysis. However, the most serious failing is the repeated statement that photoelectric observa-

tions are accurate to one part in a thousand or 0.001 magnitudes. It is true that in rare, exceptionally favorable, cases observers have reported probable errors of normal points somewhat approaching this, but the probable error of a normal is not the probable error of an observation, and the probable error of an observation is most emphatically not a statement of its accuracy. Every competent observer attempts to free his measures from systematic errors, but there are limits to what can be achieved. Recently, Kron and Smith gave a critical discussion of careful tests of their equipment (*Ap. J.*, **113**, 324, 1951) and concluded that, while linearity of electrical output to electrical input could be reduced to below 0.4 percent, the linearity of electrical output to light input was guaranteed only to 1 percent. This, of course, applied to the entire range of their equipment and may be reduced somewhat when only part of this is used, but there is certainly no evidence to indicate that precision of 0.1 percent is to be expected. Even if this accuracy were obtained by the photometer, such factors as the change in the extinction factor as the color of the variable changes will introduce systematic errors which will be much greater than this. The idea of an accuracy approximating 0.1 percent is not likely to mislead anyone who has made photoelectric observations but it may well give to a non-observer an entirely erroneous idea of the value of the observations, and of the troubles introduced even at the best of times by the atmosphere.

Another serious flaw is the discussion of graphical methods. These are severely criticized, but a moment's thought shows that the criticisms really apply only to the improper use of graphical methods—which is another matter entirely. Indeed, most of them apply with equal or greater force to the use of normal points which Dr. Kopal accepts as a necessary evil. Excellent as the book is as a description of his own methods, the discussion of other means of attack tends to leave the entirely erroneous impression that these latter are now of little value. Dr. Kopal gives a list of tables and recommends that the student keep them constantly at his elbow. This is a sound suggestion, but in order to maintain a proper perspective, it would be wise to keep at the other elbow a copy of Princeton Contribution No. 8, opened to the fourth and fifth paragraphs of the introduction.

FRANK BRADSHAW WOOD.

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Philadelphia 4, Pennsylvania.

Formulae and Directions for Computing the Orbits of Minor Planets and Comets.

The above is the title of a pamphlet of 32 pages prepared by Y. Väisälä and L. Oterma of Turku, Finland. This pamphlet is the successor to a pamphlet issued by the former of the two authors in German in 1939. In this pamphlet, after a page of brief comments in the preface, the various formulas are listed. All theory and derivations are omitted, and only the formulas are given, with such remarks as are necessary to make the use of them clear. The orbit of the minor planet 1941 FS, discovered at Turku, is determined as an example of the use of the formulas.

The computation of an orbit is a fascinating and thrilling undertaking. With this pamphlet and the necessary data at hand, anyone who has sufficient grasp of mathematics to interpret the formulas and to use logarithm tables or a computing machine may embark upon such a venture. C.H.G.

Carleton College, June, 1951.

The New Physics, by Sir C. V. Raman. (The Philosophical Library, Inc., 15 E. 40th St., New York City. 144 pp. $3.75.)

In the past decade the reading public has been made acutely aware of the rapid advances in the sciences, the science of physics probably leading. The title of the book before us therefore at once attracts the reader's attention. When he learns that the author is a Nobel Prize winner and a holder of the Honorary Doctor of Science degree from a dozen different universities, the reader's interest is heightened. It frequently happens that persons not properly prepared for the undertaking attempt to read treatises on modern developments of science only to become hopelessly lost in a maze of technicalities and unfamiliar terms. Happily such is not the case with the volume here described. The author in beautiful and concise English discusses many phases of everyday experience which, at first thought, might seem to be outside the realm of physics. However, the presentation is so basic and thorough that the title of the book is vindicated.

It is true that the reader of this book will not acquire a mastery of the theory of relativity or a knowledge of the latest theory of the structure of the atom, but he will see that physics, in a broad and comprehensive way, is worthy of consideration by all persons of even only average intelligence and that it is not the exclusive domain of the specialist. C.H.G.

Carleton College, June, 1951.

The Origin of the Earth, by W. M. Smart. (Cambridge U. Press. 1951. 239 pages. $2.75.)

Professor Smart of the University of Glasgow adds still more stature to his reputation as one of the top writers of astronomical texts and popular works by the excellence of *The Origin of the Earth.* Following on the heels of *Some Famous Stars,* the merit of which has been widely recognized, this latest book is cut for a broad audience that is well served as the exposition is as lucid and light as anyone could desire.

Giving astronomical lectures during the War to non-technical groups in the services led to the organization of the material in book form. The first nine of the ten chapters were completed in August, 1948, but the last one includes quite recent data.

There is no fairer man than Dr. Smart in the treatment of rival astronomical theories; so we are confident that the almost complete neglect of the dust-cloud hypothesis is to be attributed not to a rejection by the author but to a lack of familiarity with the interest, particularly in this country, aroused by the stimulating suggestions of Whipple and Spitzer, who are nowhere mentioned. This omission will be a serious objection to many earnest American and other students even though the mathematical development may not have been carried as far in these as in the older theories.

Violating the time-honored tradition of crowding the minor criticisms of a good book into the last paragraph, the comment will be made that the various hypotheses of evolution of the planetary system are treated so dispassionately that a few now enjoying a minimum of favor get an unexpected amount of space. It would have been of more interest if some of this had been used to express the author's own preferences.

In the short summary of Part I, "Whence?", Dr. Smart says: "It is not unlikely that the origin of the planets is to be looked for in the Sun itself, although the possibility must be not overlooked that some unknown star, now roaming

in the depths of interstellar space, is the real material parent." This leaves out variations on von Weizsäcker's nebular cloud theory, let alone the all-out dust proposals. In the added matter on page 214 Weizsäcker comes into his own but does not rate the attention given Hoyle's lop-sided disappearing nova which has enjoyed much recent success on radio and in news magazines.

A murmur must be whispered against the false economy of trying to put too much into a diagram such as that on page 84 where, in the center of a *plan* view of Saturn's ring system, an ellipse representing the *oblateness* of the planet is shown. It is also out of scale no matter how turned. An acute and literal student would see in this an ellipsodial shape for Saturn which is frightening to contemplate. In general however the illustrations are well chosen if not profuse.

Writing of illustrations, a hearty commendation must be recorded for the gratifyingly complete and understandable treatment of the carbon cycle and related processes. Nowhere do the years of teaching in the author's background serve him in better stead than in these sections which are neatly diagramed. Likewise mention must be made of the particularly effective writing which brings out engaging facets of the conflict of the "Geological Record—with Physical Science" followed by "Radioactivity to the Rescue," far and away the best treatments to be found in print today.

The chapters cited illustrate an admirable quality in many British scientists. They are often able to bring into their writings knowledge or simple similes from distant fields even though their own specialty may have been narrow. Everybody knows how Eddington was able to quote *Alice in Wonderland* in his masterpiece *The Internal Constitution of the Stars*. Professor Smart is another Englishman, who, laboring in a restricted discipline, still gives added proof to the humanists' insistence that breadth of experience and depth of appreciation aid in the best dissemination of even the specialist's knowledge. There is no doubt that his lasting influence is enhanced by his wide reading and his handsome prose style.

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